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Forthcoming Events.

APRIL 8.

Institute of British Foundrymen (London Branch):—Ordinary meeting in London. Paper by F. C. Edwards.

APRIL 9.

Diesel Engine Users' Association:—Ordinary meeting in London. "Industrial Tests on Internal-combustion Engines," Paper by W. A. Tookey.

Institute of Metals (Sheffield Local Section):—Conjoint meeting with the Sheffield Silver Trades Technical Society at Sheffield. Paper on "Silver from Mine to Market," by E. A. Smith, A.R.S.M.

APRIL 15.

Institute of British Foundrymen (Birmingham, Coventry and West Midlands Branch):—Annual meeting at Birmingham.

APRIL 17.

Institute of British Foundrymen (Newcastle-on-Tyne Branch (Junior Section)):—Annual general meeting at Newcastle.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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The International Foundry Trades Exhibition.

This exhibition, which is to be held at the Agricultural Hall in June, concurrently with the Institute's Annual Convention, has created considerable interest on the Continent of Europe. This is due no doubt to the excellent publicity which has been created for it by the organisers, who have sent out personal invitations to all the principal foundry owners of Western Europe. This communication suggests that if the foundry concerned is unable to be represented, that it might be interested to receive the exhibition guide. Acceptances apart, roughly 1,000 foreign foundrymen have asked for the official catalogue. Whilst the foundry equipment and supplies trades are somewhat devoid of a common bond, this can act favourably in their interests. For instance, it is the pig-iron exporter who has been in a large measure responsible for supplying the exhibition authorities with the foreign mailing lists. Undoubtedly exporters will, as they become more intimate with the rest of the people in these industries, be of considerable help in supplying both technical and commercial information about foreign concerns. The equipment firms, on the other hand, can often be of the greatest use to the pig-iron producers and merchants by supplying information as to the trend of affairs in the home market. There are many similar reasons why everybody who has anything to sell to foundries should join the Foundry Trades Equipment and Supplies Association. That the Exhibition should be supported by 100 per cent. of the equipment and supply businesses is of paramount importance to British industry, as the visitors from the Continent will obviously make comparisons between the June Exhibition and those which have been held at Paris, Düsseldorf, and Liége. The important Italian market has been filled up to the moment by French and German machinery, but there is no discriminating tariff against Britain, and we doubt if transport costs are higher from Britain than from the other producing centres.

It is thus essential that Italian visitors to the Exhibition should see the best class of British materials and machines.

The Scandinavians have recently evinced a marked interest in British foundry plant, and several good orders have been booked. This market has previously been fed with German machinery. Thus there must be readiness on the part of the British to please them in such details as metric dimensions, and properly organised spare part department.

The principles enunciated in the series of articles which we have published on "The Selling of Castings" apply very largely to foundry equipment, and the articles in question are, in view of this Exhibition, specially worthy of study.

It is pleasing to announce that the ban imposed by an important trade association against their members showing at this Exhibition has been removed, thus clearing the last obstacle operating against completeness.

The technical exhibit unfortunately will not be so imposing as at Düsseldorf, where two years' thought was incorporated, but the support which is being accorded to it by the National Physical Laboratory, the British Cast Iron Research, and the Non-ferrous Research Associations is a guarantee that what it lacks in size it will make up in interest and reliability.

Making a Chill Roll Mould.

By J. E. P.

The actual moulding of this chill roll mould was fairly simple, yet there were many operations that had to be performed intelligently, chiefly the building, as it had to be extra strong. Every brick laid was placed in its position with due regard to the ultimate strength of the whole structure.

The tackle was also made on the strong side. The foundation plate, foot ring, binding rings, and top plate were made of good hematite pig-iron. All this strength was necessary on account of the size and weight of this chill roll mould. It weighed 20 tons 2 cwts. 1 qr. when fettled.

The foundation plate (A, Fig. 1) was made in the ordinary manner by open sand moulding. It is a remarkable fact that loam moulders always make better open sand plates than sand moulders do. The writer, with many years' experience in practical foundry work, has yet to see an open sand plate scabbed when made by a loam moulder, and some plates have weighed as much as 10 tons. This cannot be said of the sand moulder.

The foundation plate had four lugs projecting beyond the plate proper for lifting the mould and bolting it down. Strict attention was paid to these lugs, as they had to take the weight of the

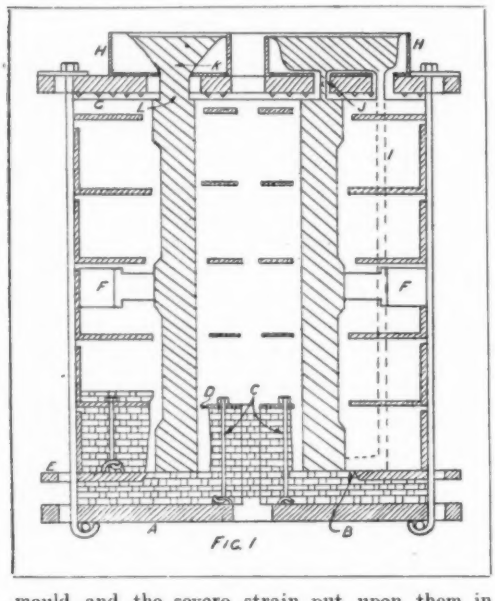


FIG. 1

mould and the severe strain put upon them in bolting down.

Holes were cast here and there to lighten the plate but taking care not to reduce the strength. Three staples were cast-in near the centre hole for bolting the centre binding plates together. The hole in the centre was large enough to take the boss of the spindle centre.

The foundation plate, after being cleaned off, was placed upon the loam floor and levelled; then the bricking up was commenced. A layer of bricking loam was first smeared on the foundation plates, then the bricks placed upon this. Very little loam was used between the bricks; about four courses of bricks were used up to the joint line B, then the core received attention. The hook bolts C were built up in the brickwork of the foundation and core, and so arranged to meet the holes in the binding plate D, which had a slot cast in so that it could easily be slipped into its position without removing the striking spindle. The other four binding plates were also made like the first one, with stops, holes and staples, except the top one, which had only holes. The slots in these binding plates were staggered in building so as not to have them in a vertical line, undoubtedly giving much strength to the building.

The brickwork of the core was practically solid; the only open part was that which was left by the removal of the spindle.

This core was not hurriedly built, and fairly stiff loam was used, so as to prevent any possibility of the loam and core sagging in the wet state, and when the core was finally struck up it was allowed to stiffen in the open air before being stoved.

The outside part of the mould was built up very much in the same manner as was the core. A dummy bottom or seating was struck up in new sand. The foot ring E was placed in its right position and the slot in the foot plate placed where the runner at the bottom was to be cut. This foot plate or ring, also the other four succeeding rings, had dabbers cast on one side of the rings at the outer edge, the top ring was plain. These dabbers were about 5 in. apart and reached to within 1 in. of the under side of the next binding ring. The bricks were placed against the dabbers all round, and when the brickwork reached the position of the first binding ring, the ring was put on and hammerd firmly down. The hook-bolts were secured, and the building proceeded, each successive binding ring being treated in the same manner.

The position of the trunnions was located by the centre of the mould, and the block prints F were built up in the brickwork. One dabber had been left off the second binding ring to allow the block prints to be withdrawn later. The bricking up was then continued up to the top joint G. This part of the mould was also allowed to stiffen sufficiently before lifting it.

The top plate was similar to the bottom plate, with the addition of holes for the runners and riser. As the joint at the top of the mould was flat, the top part was struck separately; the runners and riser sticks were placed as the top was being struck up. This also was thoroughly dried.

The three parts of the mould were then taken out of the stove and filed up. The mild-steel trunnions were then placed in the prints F and bricked in firmly and dried. The mould was then blacked with a strong, heavy blacking, and on top of this blacking a coat of good machine oil was brushed. This oil strengthens the loam facing, prevents the metal burning the loam, and gives a very nice blue skin to the casting. After the blacking was dry, the mould was closed and bolted down securely, and then lowered into a casting pit to give headroom for casting, and rammed up to ensure the mould from bursting.

The runner basin H was built up in loam on a plate or ring with dabbers in the usual manner. One down runner I with six top runners were employed. All runners were plugged, and when the basin was fairly well filled the plug on the down runner was lifted, and when about two tons of metal was in the mould, the top plugs were lifted, and the metal—which was in very good condition—ran into the mould very rapidly. There was 25 tons of metal, in two ladles, and provision was made so that both ladles could pour simultaneously.

The feeding occupied 2½ hours, several men taking turns. Twelve clean, hot rods were provided. During the process of feeding the rods were worked so as to keep the head of metal K open or liquid as long as possible. When head or riser began to solidify, it was taken out of the basin, and the basin filled up again with hot metal and the feeding proceeded with again. The performing this operation of removing the solid metal from the basin, speed is of paramount importance as it is quite possible for the metal to set at the throat L; then feeding cannot go on, new metal cannot be poured in, and the casting is in danger of becoming spongy or drawn.

The metal used was of a very high order. Only pig-iron was used, and it was melted twice. Its analysis was:—Combined carbon, 0.71; graphite, 2.65; silicon, 0.74; sulphur, 0.09; phosphorus, 0.42; and manganese, 0.75 per cent. This metal gave a very nice casting, as there were no signs of defects, and when the casting was machined the bore was clean throughout its whole length.

By experience it has been proved that iron with the above analysis is less prone to liquid contraction than some others; so much so that feed headers can be dispensed with in many cases.

In making chill roll moulds it is essential to build the loam mould solid and strong, to have the mould warm at the time of pouring, and to use a good class of pig-iron.

Power and Heat Problems in the Foundry.*

By Dr. Ing. Karl Hejcmana.

[Extract.]

An economic distribution of power and heat is not only a matter of interest to our time, but also a national necessity.

In every industry one of the largest items in the managerial budget is that of fuel and power. In the general endeavour to reduce the total costs of working, no stone should be left unturned to secure the maximum output with the minimum of costs. An annual saving of only a small percentage in fuel means a saving of millions [of Czeck crowns] to large industries.

To obtain favourable results in this respect it is necessary to solve all power problems arising in any industrial concern as a whole, and it is not possible to separate any individual branch from the general scheme of economic power distribution, for this question must be considered from the standpoint of the works as a whole.

It is precisely by the useful co-ordination of the power supply to the individual departments of a works that the possibility is afforded of effecting the greatest economy in fuel and power of the most varied kinds. Very often it is possible advantageously to employ the by-product of one department in another section; or, by combining the apparatus and centralising production, the inequalities in the power consumption of the individual sections of the works may be compensated, a more intensive utilisation of the plant being thereby obtained and the losses in working consequently reduced. Moreover, by reducing the reserve fund the invested capital may be smaller.

As an example of the first case one may cite the economic administration of the fuel supply of the large ironworks with *ab initio* production, as an example of the second case that of the supply of compressed air.

In the matter of heat and power the primary aim of the industries must be to minimise the heavy items of expenditure, the first desideratum, therefore, being the complete control of the power generation and the consumption in the individual departments of the works.

The purpose and aim of an economic heat supply is always the final financial result; that is to say, it will not always be the engineer's task to obtain the highest thermal effects in power generation—a fact which is not always considered in the fervid search for each separate calory. It is precisely in the final position of the specific consumption that any slight excess beyond the given conditions is apt to give rise on the other side to losses in production which far exceed the profit obtained. In addition, the capital sunk in improved equipment is usually very large.

Thus, in this case also there are limits which may not be exceeded, and every proposal as to the economic administration of heat and power must be based upon a reliable and proved calculation of productiveness.

Methods Available.

In heat economy the desired aim is achieved in two different ways: (1) By endeavouring, with the existing plant, to reduce the losses by means of constant supervision of working and periodical tests, and also by improved service; (2) by determining—on the basis of experience acquired by one's own or others' works, or theoretically—the conditions of working and making suggestions for more efficient and more economic equipment.

These suggestions as to new devices are subordinated to the economy of the works as a whole, methods of working and raw materials being so selected that the general useful effect of all apparatus generating and consuming energy is the highest possible, while at the same time the waste power is completely utilised. The co-operation of the heating engineer is indispensable at the present time in planning new arrangements or devices.

The first requisite in making useful alterations in the administration of the fuel and power is actual knowledge of the power conditions in each department; its balance-sheet as regards power affords an insight into the losses in the separate sections of the works.

The foundation of such a balance-sheet is a reliable table of power statistics based on measurements and calculations. It is quite impossible to carry out continuous, accurate and separate measurements of all the power apparatus in large works, nor would this serve any useful purpose. It is necessary to extract those measurements which influence the fundamentals of the balance-sheet, and these measurements must be correct. By introducing regular supervision these measurements are supplemented, so that guesswork is precluded.

Statistics would be merely dead figures if they were not examined, and it is necessary further to deal with them so that they enable the engineer: (1) To compare the working in each separate section during certain periods (*e.g.*, monthly); (2) to compare the separate departments of the works in relation to their equipment; (3) to compare works of a similar kind—which in view of their different conditions of working must, of course, be judged with great reserve; (4) to make a comparison with normal working figures which afford a minimum in the practical or theoretical values in respect of the different conditions; (5) to determine the consumption of heat and the power in the individual products; and (6) to determine the economies that may be effected by improved working.

From the individual comparisons it is possible to determine the losses in the individual working processes and to explore and eliminate the causes of such losses.

To the business management the heat balance affords a positive basis for calculating the prime costs. The statistical results relating to the economic utilisation of heat show the amounts of heat or power consumed in respect of the individual product, and these figures may be expressed in crowns and heller for each period. For the final compilation of the statistics of power consumption a whole series of established facts is necessary, from which valuable principles may be gleaned to be applied in working.

Of the raw materials which are administered by the thermo-technical department, the following should be mentioned:—

First of all, fuel of every description and water, the various types of power, namely, steam, electric current, hydraulic, compressed air and air for blowing processes.

From the thermo-economic standpoint, the most advantageous fuel is usually the best fuel, the useful effect of which is the greatest, but the best kind is usually the dearest. In respect to any given case of fuel utilisation the determining factors are:—

The product from its amount and its specific price.

The duty of the engineer is to determine the minimum of this product and to secure this figure while observing all the pre-requisites and conditions existing in the given case to which it is applied, *i.e.*, the technological working requirements, which are regarded as the primary law also in heat economy. The same applies also in equal measure to the kind of power to be used in any given case.

Foundry Fuel Economy.

How heat economy is to be adapted to actual foundry practice cannot be generally stated, and this problem cannot be solved according to cut-and-dried rules. Working conditions and circumstances differ in every foundry according to the nature of the work and production, and it is, therefore, necessary to adapt the method of power supervision to these different conditions and to develop it accordingly.

* Translated from a Paper read before the Czecko-Slovakian Foundrymen's Association. Professor M. F. Pisek presiding.

As an example in heat supervision, coke was adduced as being the most important fuel in the foundry. The requisite chemical, physical and technical properties, as also the methods of investigating them, were mentioned. The main purpose of the cupola furnace—to convert iron from the solid into the liquid state—determines the requirements as to the quality of the foundry coke, the best quality showing the most favourable combustion in relation to CO_2. Where possible, the coke should possess the lowest reduction capacity, i.e., should be distinguished by low combustibility and high ignition capacity. Ignition at 300 deg. C. and combustibility at 730 deg. C. should be regarded as minimum limits. Good grading of the coke and its resistance to pressure (its minimum is 2,133 lbs./sq. in.) are also of great importance.

The estimation of the value and of the price of coke is not a mechanical task. For purposes of comparison in respect of the individual prices of coke for cupola furnaces, in addition to the stated tests, it is necessary to make a complete calculation of all expenditure in respect to the melting, since heat losses, limestone addition, tapping slag and wages all vary according to the properties of the coke. The only criterion for the value of coke is the total result in relation to all the conditions.

With systematic examination of the coke the regular control may, of course, be greatly simplified and may be restricted to periodical technical tests, determination of calorific value, percentage of ash, moisture and sulphur.

Similarly, the conditions for examining the value of coal, the quality of liquid and gaseous fuels are also stated.

In nearly all waste from furnaces in the foundry a considerable percentage of unburnt coke and coked coal is always to be found. The utilisation of this waste in conjunction with the recovery of the iron and other metals from foundry waste is always of economic importance. Most of the methods for recovering valuable constituents from foundry waste are based on the principle of magnetic separation or on the principle of hydraulic separation according to the specific gravity. Either jigs or flotation devices, such as are used in the coal washery at coal mines, are employed. Smaller types, known as "Columbus" apparatus or screening drums, are also on the market.

As an example mention may be made of the type made by the firm Graue A.G. of Hanover, which is very suitable for smaller foundries. This apparatus is constructed in accordance with the American patents of the Whiting Foundry Equipment Company, Harvey.

With regard to the economic use of hot water in foundry work the utilisation of the heated cooling water was duly considered and directions were formulated with a view to effecting a saving in hydraulic power.

Electric Heating.

In individual foundries electric current is used for heating and running electric furnaces. The centralisation of the current supply, the correct construction of the system and economy in consumption were referred to.

At the separate points of consumption it is necessary to select the electric apparatus so as to meet the requirements of the works. Thus, motors which are too large are to be replaced by smaller ones and apparatus with alternating working in the case of large units is to be provided with automatic connecting and disconnecting devices.

The principal condition for the use of electric current in melting, drying, and heating furnaces is the low price of electric power, and, moreover, by suitably reducing the current supply to the foundry furnaces a better and more uniform loading of the current-generating devices can be obtained, provided these requirements are covered precisely at the time in which the central station is minimally loaded. Thus, by better utilisation of the central stations the costs of working are reduced. Provided the supply of current is taken at periods corresponding to the loading of the power station, it is correct to state that in the case of large current-consuming apparatus such as electric furnaces—which, in addition, improve the cos ϕ, as they are mainly resistance furnaces—a more favourable scale of charges for the required current is applied than in the case of mechanical plants equipped with only a few motors and working with small cos ϕ.

Compressed Air.

This is a highly popular and important form of energy, but, even in reference to the repeated conversion into energy of the fuel until useful work results, the final useful effect is relatively small, and this form of power is relatively expensive. It is, therefore, all the more necessary to economise its use in working and devote attention to the working and to the distribution and consumption of compressed air. As regards the costs of working in respect of compressed air alone and with electro-motor working of the compressors, the expenditure for current is 78 to 80 per cent., and for maintenance 14 to 15 per cent. From this it follows that it is necessary first of all to try to reduce the consumption of current which is dependent upon the loading of the compressors and the working pressure of the compressed air.

In order to increase the load and to reduce the idle running of the machines, the compressor plants at the author's works were connected by a

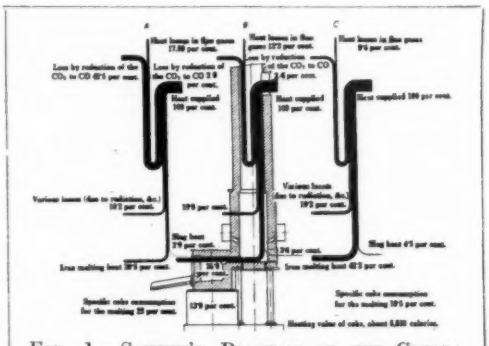


FIG. 1.—SANKEY'S DIAGRAM OF THE CUPOLA.

pipe line and half of them scrapped. The pipes were simple and the losses insignificant. The economic advantage of this arrangement could be estimated from the current consumption for 1 cub. m. of air drawn in, the amount of which, after reconstruction, was only 62 per cent. of that formerly required.

In the distribution and consumption of compressed air the largest losses were due to leakages in the mains, connecting valves, or rubber tubes, and to useless blowing and bad condition of the pneumatic tools. The experience gained in this respect was also stated, together with remarks as to the selection of the air pressure for sand blast apparatus.

The proper condition of compressed air has a great influence upon the effect of the compressed air apparatus in operation, as also upon its durability in working. This condition may be obtained by inserting in the system, in series connection, batteries of vane wheels serving to separate the oil and the water of condensation. The size of these wheels must correspond to the air consumption, so that the compressors may run smoothly.

In the vane wheels and water separators the water is separated from the air by cooling, but the volume of air is diminished. It is, therefore, advisable to pre-heat the air again in front of the point of consumption by means of waste heat, so as to obtain the former volume.

While it is possible to effect extensive economies by the centralisation of compressed air generation the opposite is the case with blowing air. This is due to the fact that it is easier to adapt the fan to the given process of the furnace than to adapt the furnace to the air pressure of the common fan. It is, therefore, more advantageous to increase the number of small fans than to connect the points of consumption by pipe lines, the leakages losses, etc., of which are very large. In addition, the effect of too large and inadequately utilised common fans is too small. "In one workshop," says Dr. Hejcmana, "we replaced two small fans by twelve small units and thereby effected a saving of 60 per cent. in current, while the output remained the same."

Cupola Efficiency.

Examples from foundry practice in the past few years were given to show the manner in which heat research operations, measurements of the plant and supervision of working were carried out.

By the introduction of a system of supervision of the heating plant in the foundry the specific coke consumption was found to be far above the normal figures, as was also the amount of heating coke and waste coke for pre-heating the ladles. Measurements were therefore taken on the cupola furnaces, and individual investigations as to the working conditions and faults of construction were carried out. "The success of our efforts was such that the present coke consumption per month averages 13.5 per cent., including bed coke, with a calorific value of about 7,000 cal., although the technical working conditions were very unfavourable to a reduction in coke consumption." In 5 to 7 grades of iron the melting temperature differs, and in order to prevent the occurrence of any intermixture of the iron the charge of coke between the individual classes must be increased. The pouring of small moulds and the long transport, render it necessary to increase the temperature of the iron at the spout to 1,360 up to 1,410 deg. C. In examining the cupola furnaces in the works, in addition to the charging, the following were measured:—

(1) The amount and pressure of the blast; (2) the temperature and the composition of the waste gases; (3) the temperature of the iron when tapped from the furnace into the ladle; and (4) the temperature and the amount of slag.

The result of the tests and measurements is given in Sankey's diagram, Fig. 1, which shows the heat balance and the distribution of the heat losses in the entire process. Diagram A shows the initial state. Large losses were caused by incomplete combustion of the coke in relation to carbon monoxide. By regulating the blast a combustion ratio of $\frac{CO_2}{CO} = \frac{62}{38}$ was obtained. A further reduction was impossible with the given type of furnace, and the position reached is seen in diagram B. Only by structural alteration in the furnace itself was a further reduction of the specific coke consumption in the melting effected. With the given technical conditions referred to above a total consumption of 10.5 per cent. was obtained in the course of the tests. The working of the furnace is shown in diagram C. The quantity of air introduced was not far removed from the theoretical amount, and the temperature of the waste gases ranged from 150 to 300 deg. C. At the same time, and by way of experiment, directions for the conduct of the furnace were formulated.

To facilitate control of the running of the furnace also in normal working, the furnaces were provided with built-in permanent apparatus for measuring the amount and pressure of the air and an automatic waste-gas analyser of the "Duplex-Mono" system, which was arranged for CO_2 and CO (*cf.* Fig. 2).

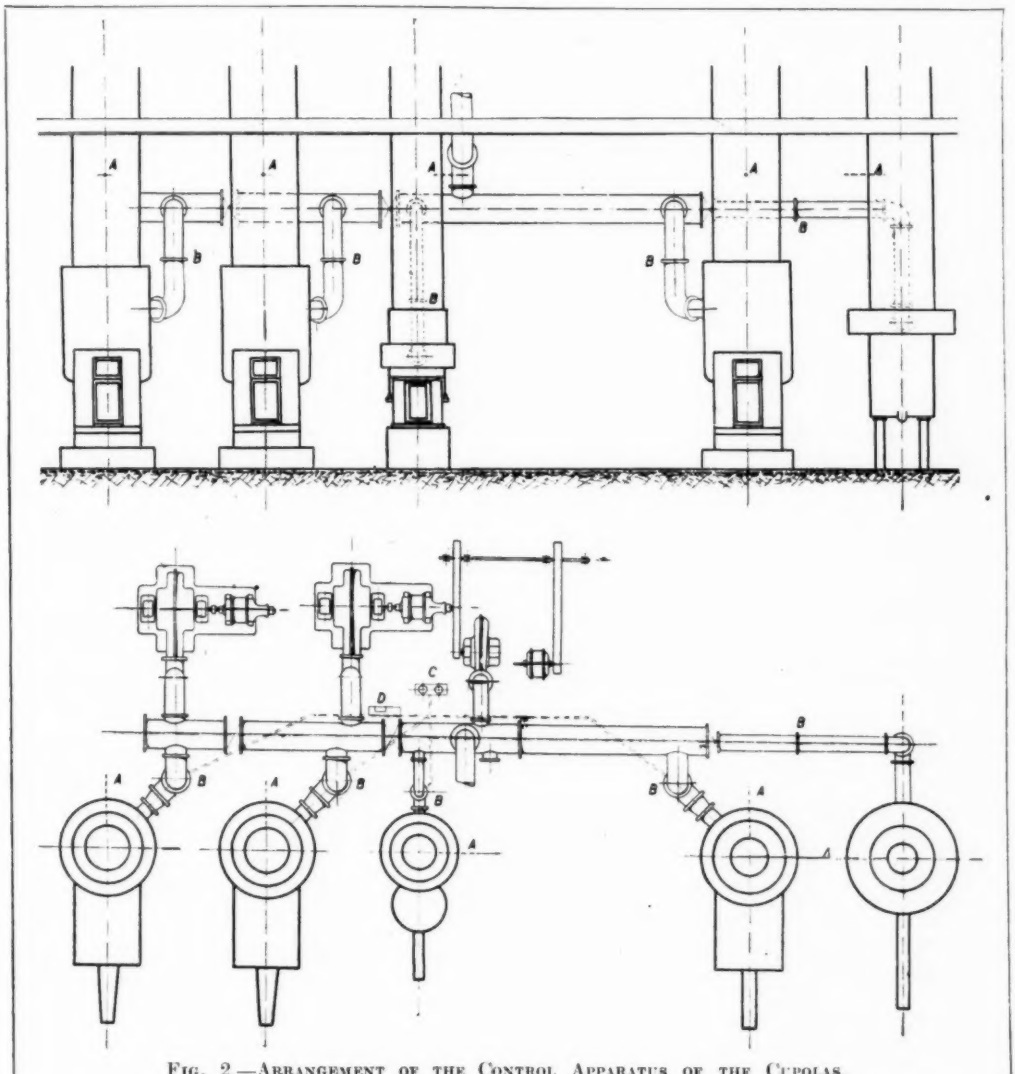


Fig. 2.—Arrangement of the Control Apparatus of the Cupolas.

A, points at which the waste gas samples were taken; B, an air-volume measuring points; C, Hydro-Apparatus for measuring volume and pressure; D, Duplex mono apparatus.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Cupola Design.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Among the several interesting articles we have recently had in the JOURNAL on foundry cupolas there have been many statements which, in the writer's opinion, should in the interests of foundrymen generally, be contradicted or qualified.

The first which might receive attention was a sharp criticism of cupola makers for continuing to supply a blast pressure gauge with their cupolas, these being stated to be of no practical value, and the only sensible proposition being a volume-pressure gauge.

Now to say that a properly-designed pressure-gauge (by this is meant one which is not dirted up and out of action in a few days after the cupola is put into operation) is useless is incorrect, because it is a very simple matter to check the volume of air passing through the cupola, if the pressure at the wind belt is known together with the power absorbed by the blower.

Apart from this, if the effective area of the tuyeres is not choked with slag, the pressure does give a daily register of the volume, because under the same conditions of resistance in the tuyeres and interior of cupola, any increase of volume will give a higher pressure-reading and less volume, a lower pressure-reading than the normal.

Further, a cupola, properly designed to melt so many tons per hour, when supplied with the correct amount of blast will have a definite pressure register if the resistances have been correctly estimated, and cupola makers know if the specified pressure is obtained taken in conjunction with the horse-power absorbed by the blower that the correct volume of wind is being supplied.

While the volume pressure gauges are a valuable appliance for cupola correction they are not suitable for being permanently fixed to the cupola for daily use, but the real reason why they are not in more general use is that the cost is more than the average foundry proprietor is prepared to pay.

In another article we are told that there is no special merit in having more than one row of tuyeres if they pass the requisite amount of air and that this practice effects a distinct saving in height of bed and therefore a saving of coke.

This statement is incomplete as it refers only to a straight-lined cupola, that is, one that is lined parallel from the hearth to the charging hole, for while one row of tuyeres might be good practice in a cupola of large internal diameter at the tuyeres, it is not suitable for a cupola which is restricted in this area, as the chilling effect on the slag by introducing all the blast on one cross section in such a case would be detrimental.

It is obvious that if it is necessary to increase the internal diameter at the tuyeres to make the cupola suitable for one row of tuyeres, the saving in the height of the bed does not save coke, as any advantage is lost in filling up the increased internal diameter of the cupola.

Again we are told that tuyeres which expand to the inside of the cupola are almost universally used without giving any warning to those whose cupolas are not suitable for expanding tuyeres.

There are many cupolas in operation where the charging platform is comparatively low, and there is correspondingly little burden or resistance in such cupolas.

In these cases increased resistance must be provided in the tuyeres themselves to obtain a good working pressure of blast, and the only possible way to get a fairly even pressure through the bed is to use a parallel on even a converging tuyere.

There is no doubt that the use of tuyeres well splayed to the inside of the cupola is the best practice, and most generally used with modern cupolas having a standard height of charging hole.

We have also been told that the parallel-lined cupola is better than the lining, which is restricted at the bottom in the tuyere area, and its use becoming more general.

Dealing with the latter part of this statement first, the parallel or straight-lined cupola is common practice with American makers, and the restricted lining common practice with English makers; and while it is possible more American cupolas are being installed here than formerly, the inference, in the writer's opinion, is exaggerated.

With regard to the merits or otherwise of this type, your readers' attention is called to an interesting portion of a recent article showing the melting zone as an inverted cone and not a well-defined area straight across the cupola, the explanation being given that this is due to the difference of blast pressure between the outside and centre of the bed coke.

This, to the writer, seems a strong argument for the use of a restricted lining, and not a straight-lined cupola, as advocated in the same article.

It is generally accepted that the more even the condition of blast right through the coke bed, the more defined will be the melting zone, and the better will be the melting conditions.

If we consider two cupolas for melting the same amount of iron per hour—one straight-lined and therefore of much larger internal diameter at the tuyeres than the other, which is restricted, as both will be supplied with the same amount of blast there will be a lower pressure in the straight-lined cupola owing to the larger diameter, more area round the charge for the escape of the gases between the charge and the lining, which is the line of least resistance, and the mouth of the tuyeres will be much further from the centre of the coke bed as compared with a cupola having a restricted diameter at the tuyeres.

The straight-lined cupola has therefore an important disadvantage in this respect as it follows from the above that the blast pressure at the centre of the bed will be much less than on the outside up to the lining, and this will defuse the melting zone in the hollow cone formation when good melting conditions demand a well-defined melting zone straight across the cupola, a condition that can be closely approximated with the restricted type of lining with the higher pressure condition inside the cupola.

There are also structural disadvantages in the straight-lined shallow bed type of cupola, as the wind belt has to be brought right down on to the drop-bottom plate and enclose the fettling, tapping, and slag holes, all points which rapidly deteriorate in the ordinary cupola, so that the wind belt will also deteriorate at these points and repairs will be more difficult and costly.—Yours, etc.,

E. A. ROPER.

Keighley, March 31, 1926.

The Foundry Cupola.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I have been much interested by Mr. Hurst's article under the above heading in your issues of the 4th and 11th inst., and subsequent correspondence on the question of temperatures attained. Mr. Hurst gave a temperature of 1,900 deg. C. (as corrected) in his thermal balance sheet. Mr. J. Shaw wrote stating that 1,333 deg. C. was more like a true figure, and Mr. Campion supported Mr. Hurst's figure, citing the cupola melting of mild steel with a melting point of 1,490 deg. C., and the fact that cupola metal has been tapped at 1,400 to 1,450 deg. C. As regards Mr. Campion's first point, surely mild steel charged into a cupola becomes heavily carburised *before* it is melted. I seem to remember having seen some time ago in the JOURNAL an account of some experiments with m.s. rods proving this. The melting point of the carburised metal would be very much below 1,490 deg. C., which rather discounts this evidence. A tapping temperature of 1,450 deg. C. is, of course, by no means unique—a cupola under my control regularly taps metal at over 1,400 deg. C.—but is this any proof of a maximum temperature in the neighbourhood of 1,900 deg. C.? In view of the rapid drawing off of the metal, I find it hard to visualise a maximum temperature more than, say, 200 deg. C. in

excess of that as tapped, giving for Mr. Campion's case of 1,450 deg. C. a maximum figure of 1,650 deg. C.

In view of the need for the production of low-carbon irons, as well as for other reasons, this question is an important one. Could not some more definite data be arrived at by an examination of the carbon-absorption of cupola-melted metal under carefully noted conditions? This should not be an expensive or a difficult business if it were carried out by a really skilled metallurgist in constant touch with cupola working.

As regards cupola lining, I suggest that maximum temperatures are probably attained only at some little distance inwards from the walls, which also are probably protected to some extent by a layer of half-burnt gases, though this is an open question.

Refractories—well, the refractory people would seem to be able to speak for themselves! —Yours, etc.,

F. D. CORBIN.

Llanelly. March 30.

[Grey iron foundrymen should bear in mind that dead mild steel can be melted in a crucible surrounded by coke, the furnace being driven by attachment to an ordinary chimney. Why should not similar temperatures prevail in a cupola?—EDITOR.]

Low-Pressure Blowers for Cupolas.

BY C. H. S. T.

The positive pressure rotary blower is, in many foundries, giving way to the centrifugal blower, on account of the fact that the latter, direct-coupled to a small electric motor, offers many advantages over the fan blower, where air has to be supplied to small cupolas. For large cupolas the advantages of the turbine-driven centrifugal blower are not only the high efficiency and the uniform steady blast, but also that its high initial efficiency is maintained with the minimum of

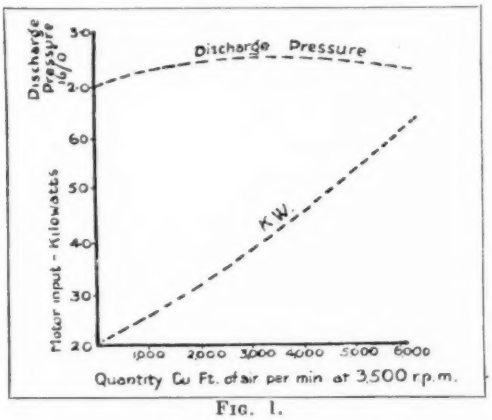


FIG. 1.

supervision. The steady melting of the iron and the uniform descent of the charge in a cupola depends upon the steady and continuous pressure of the blast, which to some extent supports the charge, and if the pressure varies there is probability of the charge descending in an irregular manner with unsatisfactory results.

A foundry cupola is operated, as a rule, only for a few hours daily, and the conditions under which it works do not produce the large variations which occur in the blast furnace. Therefore, a constant volume governor is not necessary, and the blast requirements of a cupola can be satisfied by a practically constant pressure which the blower has the capability of maintaining over the whole range of output. This point is illustrated in the curve, which was taken on extensive tests with a B.T.H. cupola centrifugal blower.

The positive pressure blower at a constant speed gives a practically constant volume and forces the same quantity of air through the cupola regardless of the depth of fire. On the other hand, a centrifugal cupola blower is self-regulating, and when the cupola is full it delivers a reduced quantity of air, so that although the metal falls through a greater depth of fire its temperature does not become too high owing to the slower rate of combustion with the reduced draught. Again, when the quantity of fuel in the cupola is smaller, the amount of air forced through by the blower is greater, a more rapid combustion takes place and the temperature of the metal is kept up, even with a smaller fire.

In computing the amount of air necessary to blow a cupola, calculations have always been based on the displacement volume of the positive pressure blower and about 500 cub. ft. of air per minute has come to be accepted as the usual amount necessary to melt one ton of iron per hour. This quantity, however, is expressed in terms of displacement air and not air actually delivered. Tests have shown that 400 cub. ft. of air per minute is the actual quantity required for each ton of iron per hour, which is the correct figure to use to determine the proper rating of a blower to meet the requirements of any cupola, and if 500 cub. ft. of air per minute per ton of iron per hour is used, the blower will be unnecessarily large for the work.

To melt one ton of ordinary phosphoric iron the average quantity of air required is $W = 120P$, where W is the weight of air in lbs. per minute and P is the pressure in ounces per sq. in. The output of a cupola varies more nearly in relation to the diameter than the area, and the maximum quantity of metal melted in a cupola will be obtained when the pressure and quantity of the blast and the diameter of the melting zone are so arranged that

$$\frac{WP}{D} = 330$$

where W is the weight of air in pounds per minute, P is the pressure in ounces per square inch, and D is the diameter of the melting zone in feet.

The iron melted in a cupola is affected in hardness directly as the pressure of the blast used. For maximum softness the total area of the tuyeres used should be one-sixth of the melting zone area, for general work one-ninth, and for steam and gas engine cylinder castings and similar work the total area of the tuyeres should be from one-twelfth to one-sixteenth of the melting zone area.

Institution of Fuel Technology.

Following upon the largely-attended inaugural meeting held on March 5 last at the Institution of Civil Engineers, London, the Organising Committee appointed thereat held their first meeting on Tuesday, March 23.

It was decided to adopt the name "Institution of Fuel Technology," which covers the wide field of activities the new Institution will represent. Within the limits of their powers of co-option of additional members the Organising Committee are extending invitations to other organisations to be represented, particulars of which will be announced in due course. Lord Montagu of Beaulieu has intimated his intention to join the Committee. A sub-committee was appointed to draft a constitution and bye-laws, and has already held its first session. It will meet at least once a week until the work is completed. After consideration by the Organising Committee a copy of the bye-laws, etc., will be sent to everyone interested, for consideration prior to a second public meeting, which will be called to adopt or amend as the potential members may think fit. A reprint of a verbatim report of the meeting on March 5 has been prepared, and is being circulated.

It is intended that the new Institution shall be thoroughly representative of every branch of the wide subject of fuel. The purely scientific side is already strongly represented, both on the Organising Committee and in the long list of those who have signified their intention of becoming members as soon as the Institution is constituted. The support so far received for the new Institution is stated to have exceeded expectations.

All communications should be addressed to the Hon. Secretary (*pro tem.*), Mr. Edgar C. Evans, Caxton House (East) Tothill Street, Westminster, S.W.1, who states that everything possible is being done to expedite matters so that, if possible, an important fuel congress may be held in London in the autumn. A number of influential fuel technologists in America and on the Continent have expressed a desire to join as foreign members.

XUM

The Manufacture of Copper.*

By C. A. Howe.

The copper ore mined in Great Britain is chiefly associated with sulphur and iron, and is known as "copper pyrites," the chemical formula for which is Cu_2S Fe_2S, being composed roughly of one-third each of copper, iron and sulphur, by weight. The ore is always found mixed with a certain proportion of gangue, which, in its turn, contains compounds of such metals as arsenic, tin, lead, bismuth and zinc, all of which are reduced during the processes of reduction, and tend to enter into the composition of the copper. It is evident that a difficult proposition confronts the smelter in order to produce a reasonably pure metal for the market, since all foreign metals contained in the ore are detrimental to it.

The method used for copper smelting, the manner in which the ores are dealt with and the type of furnace used depend largely on the nature of the ore and the locality in which the operations are conducted. In England, the reverbatory furnace is used, but on the Continent, where oxides and carbonate of copper are found, the blast furnace is employed using lime as a flux, similar to the smelting of iron ore, but the resultant copper is very impure, and has to be purified before it is fit for commercial purposes.

Swansea is the centre of the copper smelting industry in Great Britain. Copper pyrites are chiefly dealt with, though oxides and carbonates are also imported for use, since by their introduction during the various processes these may be reduced from as many as twelve to as few as six.

Copper pyrites is composed chiefly of copper, iron and sulphur, and to effect the final separation of the copper from the other two elements the smelter takes into consideration the fact that copper has a greater affinity for sulphur than iron has, and that iron has a greater affinity for oxygen than copper has. By careful treatment the iron is oxidised early on in the operation and unites with silica, passing off in the form of slag, and the copper combines with the sulphur, forming what is known as a regulus or matte; the last-named element being driven off later in the process, leaving the metal behind.

Reverbatory furnaces are used for all the operations in the Welsh process, which consists of alternate calcination and fusion until the required results are obtained.

Calcination.

The first operation is that of calcination, in which the ore is spread in a shallow layer on the hearth of an air furnace, and the temperature gradually raised, being controlled so that the charge is not fused. Air is admitted into the furnace, either through openings in the wall, or under the fire bridge, so that an oxidising atmosphere is maintained over the charge throughout the operation. To facilitate further the oxidation of the ore it is rabbled from time to time to bring as much of it as possible into contact with the flame.

During this process any volatile matter, such as arsenic, etc., is driven off, together with a portion of the sulphur; these, having been oxidised, pass off with the gaseous products of combustion. The copper and iron are also partially oxidised, and the latter has considerable importance in the subsequent operation. When the process is completed the charge is raked from the furnace into a vault below and cooled off by spraying water over it.

Fusion in Ore Furnaces.

The next operation, which consists of fusion, takes place in what is known as the ore furnace. The charge consists of calcined ore from the previous process with which has been mixed about 12 per cent. of such ores as oxides or carbonates of copper, if such are available; 20 per cent. of slag from the fourth operation from previous smelts to prevent the loss of copper contained in it, amounting usually from 2 to 4 per cent., and a flux to form a slag. After the charge has been spread evenly on the hearth of the furnace the temperature is increased until the mass becomes liquid, at which point the bath is on the boil owing to the escape of sulphur which is being reacted upon by the oxygen and escaping from the charge in the form of gas. Another reaction now takes place. As already remarked, the charge consists of oxides and sulphides of iron and copper. Oxygen, having a greater affinity for iron than for copper, the oxides of copper in the bath react upon the ferrous sulphides still contained therein, forming oxides of iron which unite with the silica from the flux and floats on the surface in the form of slag. The sulphur thus liberated from the ferrous sulphide either unites with the oxygen, passing off as gas, or, combined with the liberated copper, sinks to the bottom of the bath in consequence of its greater specific gravity and unites with the regulus or matte already there.

When the charge is really fluid and time has been given for a true separation of the regulus from the slag, the latter—known as ore furnace slag—is raked off and, as it does not contain much copper, it is usually thrown away.

The regulus, or "coarse metal" as it is now called, is next tapped from the furnace, either into water, to granulate it, or into sand moulds. It is then crushed in readiness for the next operation. "Coarse metal" consists of about 33⅓ per cent. each of copper, iron and sulphur, about the same composition as copper pyrites; but now there has been eliminated the gangue and some of the detrimental impurities.

Recalcination.

About half the sulphur is driven off by a second calcination, care being taken not to carry this proceeding too far, for sufficient sulphur must be left to form a regulus with the copper during the next stage. Arsenic, antimony or any other volatile material yet remaining is also expelled. The ferrous sulphide is oxidised, thus liberating the sulphur, forming oxide of iron which facilitates its removal in the form of slag during the next fusion.

For the fourth operation the calcined coarse ore is mixed with slag from the fifth and sixth operations, together with oxidised copper ores, and is returned to the furnace for a further melting. Under favourable conditions the remainder of the ferrous sulphide is removed and a regulus of comparatively pure cuprous sulphide—known as white metal—is left. Sometimes, when sufficient oxidising agents are not available for mixing with the charge, the process is not complete owing to a too large percentage of ferrous sulphide remaining in the regulus, because there was not enough oxygen present to unite with the iron and pass it off as slag. When this is the case the product is known as blue metal, and in this event a further calcination and fusion may be necessary.

The slag from this operation is known as metal slag, and, being fairly high in copper, is saved for future use in the second operation when it is included in the charge.

So far the object has been to rid the ore of the iron contained in it together with as much as possible of any other impurity, but sulphur has been partially retained in sufficient quantities to form a regulus with the copper. The first object by now having been attained, it remains to eliminate the sulphur, when the pure copper will remain. This is accomplished by roasting the white metal in an oxidising atmosphere, similar to that of the first calcination, to bring the sulphur into contact with the oxygen and thus liberate it in the form of gas.

After the furnace has been charged, it is gradually heated so that the charge slowly melts, after which the escaping sulphur causes the metal to boil. This acts as a guide, showing how far the operation has been carried. Iron and other

* Extract from a Paper entitled "Metals in the Brass Foundry," read before the Wales and Monmouth Branch of the Institute of British Foundrymen, Mr. P. L. Gould presiding.

foreign elements are also oxidised, uniting with the slag, which is kept well skimmed from the surface of the metal, so that the greatest possible area of the molten charge is brought into contact with the flame. When the smelter judges that the metal is thoroughly reduced it is tapped out into sand moulds. The metal thus obtained is called "blister copper," from the small blisters which form upon its surface, and contains about 95 per cent. copper and 5 per cent. of iron, sulphur and other impurities. The final operation of refining removes these remaining impurities from the copper.

The pigs of blister copper are piled up on the hearth of the furnace and the metal once more melted in an oxidising atmosphere to act upon any impurities left. At first the molten metal is in a state of ebullition owing to the escape of the sulphur. When this ceases it is a sign that practically all the sulphur has been eliminated. The process is carried so far that the copper itself becomes oxidised. Samples are taken from time to time to ascertain the condition of the metal; should the surface of the test piece rise it denotes the presence of sulphur, and further oxidisation has to be resorted to. If, on the other hand, the surface shows a distinct depression, the metal has become oxidised and is ready for poling. At this point the copper is known as "dry" or "under poled," and has a brick-red fracture and cracks when hammered.

For poling, the surface of the metal is covered with powdered anthracite and logs of green wood inserted into the charge. This produces reducing gases, which act upon the oxide of copper. Poling is continued until a test piece shows a flat surface at which time the metal is ready for tapping. It can be continued too far, and "over poled" copper results, and the test piece will again show a raised surface. It is thought that, at this stage the reduction of the oxide has been carried too far, and when this happens the anthracite is skimmed off the surface to expose the metal to the flame again. In order to have the copper at tough pitch a trace of copper oxide is necessary in the metal to counteract any trace of impurity left.

Best Selected.

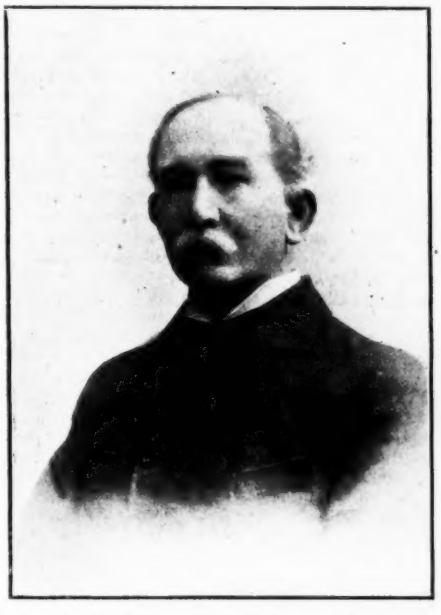
Copper that gives the best results for the purpose of making alloys is known as best selected copper; this brand contains the least impurities. It is obtained by keeping the regulus that is tapped last from the furnace separate from the earlier taps and treating it separately during subsequent operations. The reason for this is that the upper layer of regulus in the furnace is purer than that at the bottom of the bath and thus the regulus drawn off first is least pure.

One reason why it is so difficult to cast copper is because it steadily re-absorbs oxygen when remelted, and it is largely owing to this that gas holes, spongy places, etc., result. Copper castings are sometimes required, and then the metal should be melted under powdered charcoal to keep it as far as possible from the influence of the air. When the metal is molten and has been brought to a bright bluish-white heat and is free from the movement in the crucible, it can be removed from the furnace and cast, the charcoal being left on the surface and skimmed back during the turning of the metal. Sound castings have been obtained by following this practice, but if the metal is not hot enough, being of a bright-orange colour, or in a state of ebullition in the crucible, the castings will either be full of gas holes, or the metal will rise in the gates after being cast, leaving a porous casting.

When castings are to be used for electrical purposes where good conductivity is essential, the copper, of necessity, must be as pure as possible, for the slightest trace of impurity impairs the electrical conductivity of the metal, but when this property is not important a deoxidising agent is added which greatly simplifies the casting process.

Phosphorous Additions.

Phosphorus is the best of these agents, for when it is added to the molten copper the oxygen contained therein unites with part of the phosphorus, passing off in the form of a yellowish-white smoke. If the slightest trace is added to the molten copper, its effect can be immediately seen, for not only does the smoke pass from the surface, but the metal becomes more fluid. Phosphorus is rather a dangerous substance to handle, because it takes fire at such a low temperature; great care must therefore be taken in adding it to molten copper or serious burns may result. It is usual to make an alloy of known phosphorus-content with either copper or tin to afford better control over its introduction when making alloys. For greater safety in handling, phosphorus is sometimes given a thin coating of copper by immersing it in dilute blue vitriol (copper sulphate) for the space of half-an-hour. It may then be handled without danger, as long as the copper coating is intact. There are many different methods of introducing the phosphorus into the molten metal to avoid a big loss of the inflammable phosphorus. One method is to employ a hollow cylinder fixed at the end of a long rod. The sticks of copper-coated phosphorus are placed in the cylinder and then lowered into the copper or tin and left until the phosphorus has been absorbed. Another method is to employ two iron crucibles, one fitting tightly over the top of the other, the upper one having a hole through the bottom leading into the other one. The phosphorus is placed in the lower crucible and the top one cramped into position. The molten metal is then poured into the upper one, runs into the lower one through the holes in the bottom, and unites with the phosphorus therein. By this means very little of the phosphorus escapes, but is absorbed by the metal. These two methods mentioned are better than introducing it into the metal by means of tongs, because the heat would ignite it, and most of it would be lost by combustion before it reached the molten metal.



Mr. J. C. Jeffrey Smith, late Managing Director, Camelon Iron Company, Limited, and Chairman of the Falkirk Technical Institute, which is now Associated with the British Cast Iron Research Association.

British Cast Iron Research Association Scottish Committee.—In our last issue we gave the names of the recently constituted Committee of the British Cast Iron Research Association, and intimated that several firms were being invited to nominate representatives. We are now able to state that Mr. D. M. Semple (The Mirrlees Watson Company, Limited, Glasgow), Mr. L. P. Mackenzie (Mackenzie & Moncur, Limited, Edinburgh), and Mr. G. W. Wortley (R. & A. Main, Limited, Falkirk) have agreed to join the Committee.

Institute of British Foundrymen.

LONDON BRANCH.

Discussion on Mr. Longden's Paper on "Comparisons in Foundry Methods and Processes."

Mr. V. C. Faulkner said the author's remarks with regard to the Thyssen Emmel process for producing pearlitic cast iron were very interesting, coming, as they did, from an independent source, but it would be useful to know whether he had actually made tests for impact on the Thyssen Emmel iron.

Mr. M. J. Cooper, discussing the author's remarks with regard to the cupola, said it had been pointed out that a cupola of 4 ft. diameter would melt from 9 to 10 tons of metal per hour. From subsequent remarks, he had gathered that the author used a very high pressure of blast. For a long time, however, it had been stated authoritatively that the better quality of iron was not obtained with high pressure of blast, and that was his own experience. There were a few strange things about the cupola put forward by the author. For instance, he (Mr. Cooper) could not follow how one could get 75 per cent. of the blast through the lower tuyere, which, he understood, was 8 in. × 4 in. in dimensions, and the remaining 25 per cent. through the top, the dimensions of which were 14 in. × 4 in. He had also noticed that the crucible of the cupola was very much larger than the upper diameter round the boshes and in the stack, but he could not see any advantage in that. One was only filling a non-productive part of the cupola with coke. One did not want a mixing ladle in the furnace, and he would prefer receivers. With regard to the use of the double row of bricks, he said he had never seen that in practice, but would imagine that, in a cupola 4 ft. in diameter above the boshes, after the bricks had been in use a little time there would be a cutting away of 4 or 5 in. on each side of the lining, making the diameter of the lining above the boshes about 4 ft. 8 in. He did not think the double row of bricks would be very stable. Again, he could not follow the advantage of putting in coal. Why did one get more heat from coal than from coke? He had understood that there was a greater percentage of carbon in coke than in coal, and that that was why coal was made into coke. However, the author's cupola was a special one, so that probably there were special reasons for the use of coal. He had not found it necessary to put on an extra 8 in. of fuel. The author had taken 21 in. as being the accepted height above the tuyeres, and why put on another 8 in.? He could not see that the coke would crush to that extent: in an hour one would not burn 8 in. of coke in the bed. Another statement which he could not follow was that the spark arrester hindered melting. With regard to the running of the piston in the bottom, or even running it in the top, he would prefer a trough runner, and then small gates out of the trough runner into the piston casting, making the trough runner by recessing the core point, and then small runners falling out of the trough runner spaced around the casting, getting a well of metal in the runner, which was easily controlled, instead of running direct into the casting.

American Practice.

Mr. E. A. Chell asked if anyone present could solve a problem which had bothered him since he had visited the United States last October. At Yonkers he had seen a cupola in operation with an inside diameter of 4 ft., melting an average of 12 tons of metal per hour for four hours a day and five days a week; there was not an ounce of flux put on the cupola, and they did not slag out. That was a remarkable performance, and he had questioned what effect the absence of slagging out would have upon the lining. Consequently, he was invited to inspect the inside of the furnace on the following day. This was in the middle of October, and the cupola had been re-lined in August, but he was astonished to find that, although that practice had been going on, there was hardly any scoring of the lining. The cupola was double-lined, as suggested by Mr. Longden, but what had interested him was how they could produce that quantity of iron on five days a week, using no flux and there being no slagging, and still retain the lining in good condition for a considerable length of time, and further that the castings when machined were perfectly clean.

Coal in Tuyeres.

Mr. Longden, replying to Mr. Cooper, said he had not suggested the use of high blast, but only sufficient to deliver the requisite amount of air to the centre of the stack of materials, and for that he used 16 oz. Mr. Cooper might consider that high blast, but it was absolutely necessary. With regard to the diameter of the crucible being larger than the diameter just above the tuyeres, he said he had explained the reason for that. The idea was to take away the slag from around the tuyeres as quickly as possible. It was only slightly larger in diameter than above the tuyeres. With regard to the probable caving in of the inner row of bricks, he had not found that to be so in practice. As a matter of fact, he had run a cupola like that for quite six months by only taking out about 3 ft. above the top of the tuyeres and replacing them about once each week. If there were fear of the lining falling, it was only a question of knocking in a few dogs to support it. As to the introduction of coal into the tuyeres, again the object was to keep the zone about the tuyeres as hot as possible. It was a dodge one picked up from some of the foundrymen in the Midlands. It was surprising how long they could blow with a small-diameter cupola, and it was only by the introduction of coal into the tuyeres that they managed it. Dealing with Mr. Cooper's suggestion that the spark arrester did not interfere with the blast-melting, he said there was certainly very much interference with the charging, due to the issue of hot gases from the charging door. Both directly and indirectly there was considerable interference with the melting. On several days he had carried out tests with the spark arrester in position and out of position, and it was very noticeable that whenever the spark arrester was taken away there was a considerable increase in the melting rate of the cupola.

To the suggestion of running the pistons through the core, he would not agree to the alteration of the method of running which he had referred to in the Paper. If one could produce pistons of that character without blemish, year in and year out, with an average of less than 2 per cent. wasters, his advice would be not to change the method. He had made some thousands of those pistons.

Limestone Additions and Metallic Losses.

Mr. V. C. Faulkner asked if limestone was definitely essential to cupola practice.

Mr. Longden replied that it was not absolutely necessary. He had run cupolas without it, at times when he had run out of limestone altogether, but there was no doubt that one lost a considerable amount of iron.

Mr. Chell said he had seen it done in America for 15 days, making grey iron, and the melting losses were about 7 per cent., which is slightly above the average. One was usually satisfied with 5 per cent.

Mr. Longden, dealing with the splitting of the tuyeres, said that these were arranged to allow "approximately" 75 per cent. of the blast to go through the bottom aperture, and the remainder through the top. By allowing 25 per cent. to percolate through the top portion, he prevented the tuyere becoming too hot.

The top was not proportionately larger than the bottom, and the area of the top aperture was about one-third of that of the bottom, because

the front of the inside of the tuyere was blocked up with coal. With the ordinary tuyere the slagging always took place on the lining immediately over the top. This coal was renewed from time to time.

With regard to the diameter of the bosh being larger than the effective melting diameter, he said it was not much greater, and was arranged to allow any slag which fell to get away into the bosh without clinging to the under-side of the tuyere. The whole object was to get the slag away from about the tuyeres.

Hot Shots in Slag Zones.

Mr. Cooper said it did not necessarily follow that the cold air all went upwards; it went straight in and spread anywhere, and he asked why it should not cool the slag which was falling below the tuyeres.

Mr. Longden said it was inevitable that it would all rise above the tuyeres, except when slagging.

Mr. Cooper said that in his opinion the slag below the tuyeres would be bubbling, and there would be the same action as was going on in a side-blown Bessemer converter.

Mr. J. W. Gardom said that the author had referred to the many different foundry methods applied in the various parts of the country, and, apparently, was pleading for standardisation. On the other hand, he himself considered that it was a great advantage to have a practical man, to let him have his own way to a certain extent, and to play up to him, because there were so many things which at present we could not realise practically, but which the practical man knew and applied unconsciously. Dealing with cupola design, he said that Mr. Longden had objected to the single-tuyere cupola, *i.e.*, in which the tuyere ran almost the whole way round the cupola, principally because he did not get hot spots for the slag to fall through. If one did not get those hot spots, however, how did the iron fall through?

Mr. Longden: The slag falling down the lining.

Mr. Gardom: Well, the iron would follow the same course.

Mr. Longden: Not when the bridge is formed.

Mr. Gardom did not see why the slag bridge should be formed any sooner than the iron bridge. The iron, melting at a lower temperature, would cool much more slowly, and the reason it got into the bed was because it was superheated. He did not see why the slag was not superheated, even allowing that it was not such a good conductor. He had had a cupola blown for six hours that day, in which he was melting 90 per cent. steel, and he thought everybody would agree that he was likely to get slag. The cupola had single-height tuyeres, and he supposed he was able to do it simply because of the superheat. The results obtained in America when melting without slag, as mentioned by Mr. Chell, was certainly very interesting, but he wondered whether there was any slag when they dropped the bottom. There was 48 tons of iron, without slag. To produce slag one must have a slag-forming material, but that slag-forming material could be eliminated by using machine-cast pig and clean scrap.

Mr. Longden said that Mr. Gardom was mistaken in saying that he had put forward a plea for standardisation. With regard to tuyeres, he said he had had some very painful experiences with the single row, and he could not be persuaded to install a single row of tuyeres stayed out to form a continuous ring of air.

Mr. Chell, replying to Mr. Gardom's reference to the melting which he had seen in America, said that the pig-iron was machine cast, the scrap was no cleaner than that used in this country, the pouring was continuous—there was not a receiver—and the amount of slag that he had seen from the drop of the 48-ton blow was about equal to the amount obtained in this country with a 10-ton blow. That was one of the points that had interested him.

American Manufacturing Conditions.

Mr. F. Bullock (Assistant Secretary, American Society of Mechanical Engineers) extended, in advance, a hearty welcome to the Britishers who would be attending the Detroit Convention of the American Foundrymen's Association this year. Speaking of the present vogue in England, of trying to simulate American practice, he said that perhaps it might be a mistake for Englishmen to try to copy American practice in all things. The psychology of the whole country of America was different from that of Britain. It seemed to be assumed in this country that mass production had been practised in America for a generation, but, as a matter of fact, America went in for high speed mass production after the war. They had made a mistake, however, and had experienced a big slump in the following year. Now, however, they were on their feet again, and the Press, and others, were quite optimistic. Recently there had been quite a slump in the stock market, which was expected, and there would probably be a serious depression in about six months' time, so that he did not think it was wise to follow America too closely. The Ford car, said Mr. Bullock, sold at about $320, or about £60; the factory cost was about $80, or £16; and the engine gear complete cost $22, or about £4, so that one could imagine how much the machining of castings and that sort of thing was worth. The whole object was to secure a very high ratio of factory cost to selling cost. The Singer sewing machines were selling in America at $60, or about £12, and the complete factory cost was $9. The Underwood typewriter was selling for $120, or about £22, and was costing $15 to make. That was done by making, say, half a million machines. There was a great deal of difference between American and English methods, and he did not know that England would be going in the right direction by following America exactly.

The Branch-President expressed appreciation of the remarks made by Mr. Bullock, and assured him of a hearty welcome at all times. Dealing with the question of the standardisation of foundry apparatus, he said that the cupolas of England were pretty well standardised, and even the most ardent advocates of standardisation did not intend that all cupolas should be of one exact type. In his experience the cupola was standardised to a great extent, but practice was not, and it was very curious to hear the divergent views expressed by different people as to what could be got out of their particular cupolas. Commenting on Mr. Chell's remarks, he said he had read some literature on American foundry practice, and had been astounded at the marvellous results obtained, but apparently they did really get the results they put into print. He had visited a number of foundries, and had been impressed by the fact that wherever he had seen cupolas with a double row of tuyeres, the top row was stuffed up. He supposed the successful or unsuccessful running of a cupola was largely a matter of the practical experience of the man in charge. Cupola practice was a long way from what he would call a safe position, and if anybody, no matter whether American, German or any other nationality, could put it on a good practical basis, it would do much good. With regard to the dropping of the bottom of a cupola, he recalled an occasion on which, as a boy, he had helped the fireman pull out the bottom from one of the fixed bottom variety, and, if he had his way, from the humanitarian point of view he would never allow the installation of a cupola with a fixed bottom.

Double Walled Cupolas Satisfactory.

Mr. A. Gibb, referring to the double row of bricks in the cupola, assured Mr. Cooper, from his own practical experience, that there was no need to get nervous about the bricks falling. At the foundry of the London and Northern Eastern Railway they had had thirty or forty years' experience of the double row system, and nobody had been injured. They had no iron angles round the inside of the furnace to hold the bricks in, although it constituted an improvement. With regard to the system of burning coal in the tuyeres, he said that it had been used in London, to his own personal knowledge, for forty years. As to the double row of tuyeres, he had visited various foundries in which he had noticed the top

row of tuyeres blocked up. He did not see the utility of having the tuyeres split up and putting coal in at the top; it could be done just as effectively without splitting them up. Dealing with Mr. Chell's reference to the American cupola, he considered that Mr. Gardom had hit the nail on the head when he had referred to machine-cast pig. The iron must have been of extra good quality, and the coke very low in ash content, whilst also the less flux used, the less slag would be made. The thing that mattered was what were the castings going to be like when machined, and he asked whether they were machined or whether they contained any amount of cinder.

Mr. Chell said they were perfect.

Mr. Gibb, referring to the furnace discussed in the Paper, said he did not quite agree with the very low well, and he gathered that Mr. Longden used a receiver.

Mr. Longden said he did not use a receiver in the outlined furnace. Dealing with the question of coal in the tuyeres, he said it was a matter of keeping the tuyeres in a good condition. It was not only wise to introduce it just at a time when excessive slag began to form, but also soon after starting blowing, to prevent that excessive slag forming. If a cupola were to run for a considerable number of hours, one must have that object in view, and that was the practice he would always follow. Again, if one used more than the amount of coke necessary to melt the metal, the tuyeres could be kept hot, and if the bed were raised by using an excess of coke, there was a deeper zone through which the metal, and also the slag, passed. It was not the case that there was a definite zone where the metal and slag melted. It altered during the blow, due to variation or irregularity in the working of the cupola, and that was chiefly due to the slagging up of the tuyeres. Therefore, he urged that the tuyeres be kept clear, and the method outlined was to keep them clear.

Vote of Thanks.

Mr. J. Ellis (Past-President of the Institute), proposing a vote of thanks, referred to the diversity of the tackle used in the various foundries. For instance, that evening they had seen half-a-dozen or a dozen different kinds of gaggers, all of which were quite all right and could be used by any man satisfactorily. Then there was the little frame which Mr. Longden had illustrated, and he supposed that no two foundries would make that frame alike. He asked how he made the joint at the panels, and whether he had a supplementary frame to pass over the pattern when ramming the cod up. In connection with the design of cupolas, every man had his fancies. Some liked one row of tuyeres and some liked three rows, but invariably, when there was more than one, the top row was blocked up. When there were two there was more chance of scaffolding.

This Mr. Somerfield seconded.

Mr. Longden responded. Replying to Mr. Ellis's question with regard to the hinged moulding box, he said that he simply clamped boards to the panel openings until the inside was rammed up. With regard to tuyeres, he still adhered to the one row, but his objection had been chiefly to the splayed out tuyeres, which gave a continuous ring of air round the cupola. There was not the slightest doubt, from his experience, that slagging was very rapid and pronounced. He had not found in practice that when there were two rows of tuyeres the top row was always stopped up. In one cupola used in his foundry at present there were two rows of tuyeres, not very far apart, and the tuyeres were not splayed out, but ran straight in; he considered that was far better. There was never any desire to stop the top row, but if it were stopped up he considered it was due mainly to laziness and a lack of desire to keep it open.

The Bucyrus Company have removed their London offices to Windsor House, 83, Kingsway, W.C.2.

Mr. J. A. Fisher, chairman of Bell's United Asbestos Company, Limited, after nearly 48 years of service in connection with the asbestos industry, has expressed his wish to be relieved of a part of his responsibilities as a joint managing director of the company, and the board have arranged for him to be retained as consulting managing director.

The Metallurgical Student in Industry.

The organisers of the recent conference on this subject requested us to throw open our columns for the further discussion of this important subject. We feel that no good service could be done, as employers utilising the services of trained metallurgists would compromise their position by so doing, and after all these are opinions which would be most valuable. We think that the metallurgical student should be made to realise, whilst he is still studying, that unlike most positions in industry, that of the metallurgist has to be made by the holder for himself. The directorate usually have some vague notion that a metallurgist would be an acquisition to the staff, but on appointment the man has to make a position for himself. We advise the student to ascertain in what directions he could be of service to the various types of works and in his application indicate these, unless, of course, the position is one of an assistant in an established metallurgical department. A live student can often save his salary merely by attaching himself to the buying department. Then he should interest himself in improving the product and finally help the sales department by advising customers on their mutual metallurgical problems. If a student applicant can convince a directorate of his ability to accomplish these duties satisfactorily, he will help to create a larger demand. If he is content to be a hack-analyst, he will find himself in competition with ex-laboratory boys, from which class manufacturers have available a reserve of reliable chemists. Under the wonderful system of evening classes to be found in all the large cities, it is possible for this class not only to compete, but to compete very successfully with the day trained metallurgist, as they have the advantage of assimilating over the whole period of their "apprenticeship" works atmosphere.

The Copper-Rich Aluminium-Copper Tin Alloys.*

By D. Stockdale, M.A.

Summary.

In this Paper the effect of tin up to 9 per cent. by weight on the structure of the yellow aluminium-copper alloys is discussed. A remarkable feature of these ternary alloys is the manner in which the two binary systems merge into each other; there is no abrupt change in a series of solid solutions, and the difference between the structure of a β-bronze and a β-aluminium-copper solid solution, for example, is small.

The line on the ternary diagram marking the limit of the α-solid solution is nearly straight at high temperatures. At ordinary temperatures, however, it is slightly curved, because when the two added elements are present in about equal proportions the temperature of the eutectoid transformation is raised about 100 deg. C.

In a certain small number of these alloys the eutectoid transformation does not take place, but near 600 deg. C. the ordinary β-solid solution changes over to a second solid solution indistinguishable microscopically from the first. A proportion of the solid solution poor in copper may dissolve in this new constituent, and, on further cooling, the copper-rich α-phase separates out, but the mother constituent persists down to the ordinary temperature. It is for this reason and also because tin has a retarding influence on the ordinary eutectoid transformation in the aluminium-copper alloys, that there are grounds for hoping that a ternary alloy for practical use may be found which will possess the advantages, with none of the disadvantages, of "aluminium-bronze."

Mr. Frank Russell, the chairman of the General Refractories Company, Limited, of Sheffield, has been elected a member of the Works of Urban District Council.

* A Paper presented to the Spring Meeting of the Institute of Metals.

Aluminium Foundry Practice.*

By George Mortimer.

INTRODUCTION.

With the growing necessity for cutting working costs in our industries to-day, there may be traced a tendency to investigate new and more rapid methods of production, closer and more scientific control of processes, materials which will do the work and cost less.

The founding of metals is one of the few skilled trades left: one of the few where personal experience cannot entirely be replaced by ingenious mechanism. Machine moulding, pyrometric control, automatic transport, the scientific handling of sands, all the varied paraphernalia that go to the making of a modern foundry, merely assist that experience: they do not supplant it. It is difficult to think that they ever will.

Since foundrymen deal, then, not with an exact science, but with a subject complicated with all the variables of human experience, it is possible only to generalise. But if one foundryman's meat is another foundryman's poison, there is common ground in this: that all foundrymen who are successful in the casting of aluminium follow, whether they know it or not, certain fundamental principles. There are one or two peculiarities in the light metal as compared with brass or iron. Where these are recognised and met in a simple and logical manner, there will be found the most consistent success with aluminium.

These differences are set out in the following paper indicating their effect on choice of alloy or method or plant. Should questions arise at any time on the better method of meeting certain special circumstances, the author will always be pleased to augment these notes with more specific information.

Modern developments have produced a confusing array of light casting alloys, the possible combinations being in point of fact unlimited. To clear the ground it is only necessary to remember that the permissible range of physical properties is not unlimited. This range may be obtained, for all practical purposes, as readily by the manipulation of one or two simple and cheap components, as it can be by ringing the changes on half a dozen of the more costly of the rarer metals.

Since this is the case, it is wise to confine attention to a few alloys which call for no specialised foundry knowledge or subsequent treatment, which have been tried out for years under varied conditions of service and climate, and which may be regarded generally as sound substitutes for commercial brass and bronze.

"L5."

The best known of these in this country is "L5." Some thirty years ago, when aluminium casting was in its infancy, it was found that the pure metal could be cast. It is still being cast to-day in quantities, for chemical plant and similar work. It was found further that the pure metal gave poor engineering properties in the cast state, and was difficult to machine. The addition of zinc improved matters considerably, and zinc alloys became popular here and on the Continent, the proportion varying between 8 and 20 per cent., and settling gradually in this country to a compromise of 15 per cent.

Zinc is one of the cheapest hardeners of aluminium, easy to mix, tough and reliable in service, readily machinable. In the foundry, however, it has one real drawback, in that for a considerable range of temperature after freezing all zinc alloys are excessively weak. They are tender in the mould, and this at a time when a lot of the contraction is taking place. In foundry terms, the zinc alloys are "hot-short," and this hot-shortness is a prolific source of cracked castings.

Value of Adding Copper.

Substituting some 3 per cent. of copper for the same amount of zinc materially helps matters, with no loss of strength or machining qualities. Such an alloy, consisting of 12 per cent. of zinc, 3 per cent. of copper, balance commercial aluminium, has been in use for some twenty years, on such parts as gear-boxes, crankcases and other highly stressed units on automobiles and aircraft engines. For years it was known to the trade as "No. 6" alloy of the British Aluminium Company, but during the war all available data on light alloys was collected and tested out, and definite specifications were issued for all of proved merit. The specification number of this particular alloy became "L5." Minor modifications in the wording and terms of the specification from time to time have resulted in the name "2L5," the properties of which are summarised at the end of this section.

From the foundry point of view 2L5 is an easy alloy to work with, and it is suitable for a vast range of parts made in brass, in comparison with which it is one third the weight, more rapidly machined, and cheap.

The Disability of Zinc.

From the engineering point of view the material is stiff, strong and stable in all climates, and its long record of reliable service in so great a range of applications tends to give confidence to designers. In applying it to engineering parts, however, one point should be kept in mind. All the zinc alloys are weak at high temperatures. 2L5 is never used for automobile pistons, and should not be used for any job required to withstand a similar range of temperature. Castings required to withstand high temperatures are better cast in a straight copper alloy, the best known of which in this country is 3L11.

The Value of a Straight Copper Alloy.

At the time when founders in this country were discovering the utility of zinc as a hardener in aluminium castings, America was passing through a similar teething stage in regard to copper. From that day to this American founders have continued to use copper for all purposes where the British use zinc, and popular opinion has gradually settled down to an accepted standard alloy containing from 7.5 to 8.5 per cent. copper, balance commercial aluminium. This alloy, under the name of "No. 12," is used to this day in the States for about 90 per cent. of their vast output and range of aluminium castings, whether for general work or for special aircraft castings, whether cast in sand or in dies. This is in itself a sufficient testimony to the reliability of a simple copper alloy.

"3L11."

Soon after the war commenced, efforts were made in this country to find a more satisfactory alloy for aircraft pistons than was afforded by the zinc group. One of the more successful was an alloy consisting of 7 per cent. copper, 1 per cent. zinc, 1 per cent. tin and the balance being commercial aluminium. This was given the title "L11." Later it was found that even this small percentage of zinc was detrimental at high temperatures, and so it was omitted, and in place was 2L11. Later still, the tin content was made optional: it is difficult to see quite why it was ever included, except possibly on the grounds of a slightly lower crystallisation shrinkage. The final specification, since one never uses the tin, is a straight alloy containing 7 per cent. copper and known as 3L11. For all practical purposes, therefore, it is now identical with the well-known and deservedly popular "No. 12" of America. As such, it is a safe and reliable alloy to use as a substitute for brass, and has an advantage over L5 in being better able to withstand high temperatures.

Increasing the Copper Content.

Now, for various reasons it is often of advantage to increase the copper content. For instance, the higher the copper content, the lower the total shrinkage, and this may help on the production of one or two obstinate castings. Again, within limits the more copper used the less the tendency to general porosity, which point is of value in

* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. J. Masters presiding.

connection with castings designed to withstand hydraulic pressures. Finally, a higher copper content gives a hard, well-finished machined surface, eminently suitable for such wearing surfaces as automobile pistons.

The indiscriminate addition of copper, however, brings its own penalties in a rapidly increasing brittleness in the casting, and in an increase in weight disproportionate to any gain in strength.

Use of Manganese.

To guide founders and designers alike in the matter, a specification was issued for a 12 per cent. copper alloy, now known as L8. This alloy is the one used for the great majority of motor pistons cast in this country, whether cast in sand or in dies. The copper may be increased another couple of points without undue detriment, and if to this is added from 1 to 2 per cent. of manganese a useful alloy is obtained, having the property of *increasing* in tensile strength with rise of temperature up to about 250 deg. C. The alloy L8, however, holds its own in popular esteem on account of its greater ease of casting and its higher thermal conductivity.

The above alloys represent the repertory of the majority of aluminium founders in this country, and the brass foundry need go no further to meet the requirements of 90 per cent. of the cases where brass or iron is normally used now. They are recommended by this company on account of their facility of working, and their long record of reliable service under extremely varied conditions of design, duty and climate.

For comparative purposes, their specified physical properties may be tabulated alongside those of ordinary grades of commercial brass and iron.

*Material.	Tensile strength. Tons per sq. in.	Elongation on 2 in.	Specific tenacity.
2L5	11/13	3/5	115
3L11	9/12	3/4	87
L8	9/12	1	86
Brass	18	40	59
Bronze	18	40	57
Grey Iron	12	—	47

* Minimum results called for on a standard test bar.

Specific Tenacity.—In the last column for the sake of comparison is given an arbitrary figure obtained by dividing the tensile strength in tons per sq. in. by the weight of a cubic inch of the material in pounds. This factor was introduced by Dr. Rosenhain some years ago in a praiseworthy attempt to convey comparatively the effect of low specific gravity as a factor in design of any parts subjected to inertia stresses.

Such cases are innumerable in practice, and a few typical instances are cited in a later section. The specific tenacity factor is of comparative value only, and obviously cannot be used very freely for absolute calculations in design. It does serve to explain, however, why in certain applications a relatively weak material like aluminium can give greater reliability in service even than cast steel.

In further regard to the above table, it is fully understood that results on all the materials may, under controlled conditions, exceed the figures given. It is also understood that many special brasses and bronzes are available, giving physical properties in one way or another far in excess of those averaged by the common materials cited. It is merely a question of choice of an alloy for some particular duty, and a decision as to whether the circumstances warrant the extra cost of raw materials, special foundry practice, or subsequent heat-treatment.

Similarly there are special alloys of aluminium, for such special cases as justify their study and extra cost. There are alloys of nickel and magnesium, of silicon, manganese and lithium: alloys which give the strength of mild steel at a third of the weight, or which may be bent double with a hammer in the cast state without fracture, or which are relatively free from corrosion by seawater, or possess a high electrical resistance or a low coefficient of expansion.

The British Aluminium Company, Limited, will always be pleased to advise on the choice of an alloy for any special duty, give hints on any modifications in design needed, and any special treatment needed at various stages of manufacture.

Simple copper-zinc and straight copper alloys as given above, however, will be found to cover most of the requirements of general brass foundry work. They are relatively simple to work in the foundry, and they are well understood by designers. By a logical variation of the proportion of the constituents it is possible to co-relate the tensile strength and ductility factors in a convenient manner, and obtain the whole of that permissible range of physical properties which is compatible with simplicity and low cost.

Making the Alloys.

The author's firm is prepared to supply the above alloys and many special ones ready for use in ingot form, melted and alloyed under ideal conditions. Many founders prefer, however, to mix their own melts, and to these are offered the following hints.

The technical success of aluminium founding begins with the purchase of materials, for the word "aluminium" in the open market still covers a multitude of sins. "Clean aluminium scrap" may mean anything; the best available analysis does not tell the whole story. "Remelted ingot" is a pitfall, unless the history of the metal is known. Indifferent zinc and copper can ruin the best workmanship.

Virgin aluminium should be purchased in the first place. It will be found subsequently that, firstly, a certain addition of "scrap" definitely improves castings as in the case of iron, and, secondly, that sufficient scrap is forthcoming from normal foundry operations to eliminate any necessity for purchasing from outside. If it should become necessary to buy scrap, two points should be watched; the scrap should be in large lumps, and it should come from a known and approved source. One reason is sufficient for both precautions, and that is the well-known affinity of aluminium for oxygen. Aluminium invariably has a coating of oxide on its surface; excess of oxide is detrimental, therefore limit the superficial area of added scrap. This automatically eliminates machine swarf, the treatment of which will be dealt with later. Again, if oxide forms instantaneously on solid aluminium, it obviously forms even more readily on molten metal. It is therefore advisable to purchase scrap, if it ever becomes necessary, from some concern which understands the melting of the metal and has a name for a high-grade product.

The specifications outlined insist very wisely on maker's own scrap being used, and the best castings will not contain gates and risers from previous casts.

Copper and zinc must be of the best electrolytic ingot available wherever high class, reliable work is contemplated. In the case of second grade castings, where only a stiff, cheap structure is required, the founder will use his own discretion. Bus-bar clippings, and a cheaper spelter are quite good material where it is not necessary to guarantee physical properties to strict specification. The saving, however, is generally small because of the relatively small proportion of these metals used, and there is another economic factor which should be kept in mind even on the cheapest grade of work. That factor is the percentage of foundry wasters. A run of obscure trouble in the foundry is so often run finally to earth in the quality of the spelter and copper used that, generally speaking, it pays on a running job to pay more for these materials and cut out this potential source of trouble and loss from the start.

Alloying.

Zinc is simple enough to handle, being added direct to the melt. It should be added last and stirred in, care being taken to avoid undue turbulence at the surface of the melt. Add about 2 per cent. more than is required in the final analysis, to allow for oxidation and volatilisation losses.

Copper is best added in the form of a rich alloy previously made up, and there are two good ways of doing this. In the first a known quantity of copper is melted, and aluminium is added to it a little at a time until a 50/50 alloy is obtained. Stir thoroughly and pour into chill moulds. The resulting ingot may be added direct to the melt in the correct proportion, without raising the tem-

perature of same to the high figure reached when copper is added direct.

In the second method aluminium and copper are melted in separate crucibles in the proportion of two to one by weight. When molten the copper is poured into the aluminium, stirred in, and poured off into chill ingots. This gives an alloy with a copper content of approximately 33 per cent. The eutectic point of the copper: aluminium system is approximately 32.5 per cent., and this composition has the lowest melting point. As this is about 535 deg. C., this rich alloy will dissolve away almost immediately on being introduced into the melt, which is normally at about 700 deg. C.

Comparing the two methods, the latter is probably a needless refinement. The 50/50 hardener functions admirably in practice, is brittle and easily broken up, is easier on the whole to calculate for varying melts, and does not need the melting of so much aluminium in its preparation. This latter is quite a point, because of the high latent heat of fusion of aluminium: it takes a lot of fuel to melt a pound of aluminium, and one therefore tends to avoid remelting that pound.

A Few Notes on Blowing Machines.

By "Vallishe."

At one time rotary or positive blowers were considered the best means of providing blast for the cupola. In fact, it was universally agreed that high-pressure blast was practically essential for cupola work. Times have now changed, however, only to show that this was a fallacy, and the practice has now fallen into entire disuse, except in the case of very old foundries whose plant is far behind the times. The majority of cupolas are now made for use with what is known as low-pressure. These cupolas are built with a much greater tuyere area, this, of course, permitting a larger volume of air to pass through at a lower pressure.

In the case of cupolas with small tuyeres, a high pressure blast is imperative. Much is lost by having inadequate tuyere area in the cupola. Nothing can be gained in melting by forcing the blast through a small tuyere into a cupola at a great velocity. This sometimes leads to the idea of increasing the power of the blower, which is a great mistake. It is the volume that is required, not the pressure alone, if good melting is desired. It may here be said that one can be easily misled by the pressure registered on the cupola pressure-gauge. These gauges are at times far from accurate (in the way they are meant for), and it is not an uncommon affair for the pressure-gauge to show a high pressure of blast when very little blast was entering the cupola, owing to the size of the tuyeres. One is thus forced to admit that a good blowing machine is entirely wasted if the cupola is not of first-class design, with adequate tuyere area and suited for the type of blower to be used.

Comparatively low pressures and large volumes have many advantages, viz.: (1) The cupola linings have a much longer life. (2) The liability to slag is not so great as in the cases of higher pressures. (3) The power required to drive the blower is much less than where high pressures are used. (4) The castings obtained are of a smoother nature and are generally easier to machine. (5) It has been found that in many cases the metal is of greater strength as compared with high pressures with a common mixing. (6) The mechanical efficiency of the blower is greater. (7) The floor space is much less than required by a rotary or positive blower. (8) The pressure is maintained at a steady rate and the volume is generally even and free from pulsations. (9) The weight of the fan is less. (10) The risk of breakdowns is not half so great as with positive blowers, and repairs are practically nil if the proper attention is given to them.

This modern type of cupola fan is designed and constructed for delivery up to about 30-in. water gauge. It is made in a variety of sizes, and a range of from ½ ton to over 20 tons of metal can be melted per hour. Perhaps it is needless to remark that these fans have been rapidly gaining favour during the last few years, for in these times of strenuous competition the foundryman must modernise his plant in order to "keep in the hunt." Although the foundries of Great Britain have experienced practically five years of depressive trade, it has served to wake up the many foundrymen who, during the long boom, were content to stand by out-of-date methods instead of modernising their plant.

Selecting a Blower.

There are several important points and factors which must be determined before finally deciding on what type and power of blower to use. First determine the quantity of metal that the cupola should melt per hour. Then supply it as nearly as is possible to determine with the amount of air that is required to melt that weight in the certain period over which the melting extends. This factor must of course vary, owing to different conditions, but it is generally found that this quantity varies somewhere round 35,000 cub. ft. of air per ton of iron melted.

The known effective power of a blower cannot be realised in the cupola. Losses occur during transmission and other modifications which do not register on the pressure-gauge. These variations must be determined by the cupola-man, their sum estimated, and the blower then adjusted to allow for them. It will thus be understood that the power of a blower must be as follows: Theoretical amount of air per ton of iron melted plus amount represented by loss in pipes, tuyeres, etc., plus a determined factor of safety or reserve power. The latter and third item may seem of little importance to some founders, but it is here that many fall. If little or no reserve power is allowed the wear and tear on the blower when on full load is considerable, and this in turn is bound to reduce its potential capacity. Again, suppose a larger cupola is at some time desired, the blower is then found to be underpowered.

Without doubt the cupola is an apparatus whose factors are constantly changing. The founder seeks for a common factor as a basis on which to work, and here we come to that factor which represents the volume of air required to promote combustion (referring to a coke furnace) necessary properly and efficiently to melt one ton of iron. This factor has been found to be invariably constant, and should in the first place be accurately determined. When bad or faulty melting then occurs, this factor should not be altered, but steps should be taken in the proper modification of the variable factor until the desired result is obtained.

The Hardness of Cold-Rolled Copper.*

By Samuel L. Hoyt, Ph.D., and T. R. Schermerhorn.

Summary.

Hardness tests of two series of cold-rolled copper bars are reported in detail, one which had received a 2 per cent. and one a 10 per cent. reduction in thickness per pass. These confirm the old or "conventional" form of relationship between the degree of working and the hardness. In neither case did the authors find either the anomaly noted by Alkins (the "Alkins" effect) or the reversal noted by Rawdon and Mutchler. However, they do believe that they have observed a well-pronounced Alkins effect on another series with heavier reductions, not recorded here. The deviations from a smooth curve which may be seen on the hardness curves may be accounted for as due to unavoidable experimental errors. The draft per pass had only a subordinate effect on the hardness, but, in the two cases reported in detail, the 10 per cent. reduction had a greater increase in hardness than did the 2 per cent. reduction per pass.

The hardness over the cross section was found to be uniform for reductions above 20 per cent. At the start, with small reductions, the authors found the top surface to be harder than the side of the test-bar. This difference disappeared at about 10 to 20 per cent. reduction.

* A Paper presented to the Spring Meeting of the Institute of Metals.

XUM

Trade Talk.

The Binders International Company, Limited, 56, Mosley Street, Manchester, have removed to 9, Albert Place, Bridge Street, Manchester.

Alloy Welding Processes, Limited, report contracts for the supply of three two-operator electric arc welding machines for the Eastern Bengal Railway.

Ed. Bennis & Company, Limited, announce that Mr. J. G. McLean has ceased to represent them on the North-East Coast and Sheffield and district areas. For the time being business from those areas is being dealt with at the head office, at Little Hulton, Bolton.

It is interesting to note that the crankshaft and distributor bearings fitted to the Bristol Jupiter engine of the "Bloodhound" biplane, which recently broke all world's records for reliability, were supplied by Ransome & Marles Bearing Company, Limited, of Newark-on-Trent.

John and Edwin Wright, Limited, Universe Wire Rope Works, Birmingham, announce that in consequence of persistent rumours which have been prevalent they are not, and have no intention of becoming, members of any combine or amalgamation of rope manufacturers.

Japan has placed an order for 5,000 tons of 100-lb. rails in the United States. The rails are to be of open-hearth steel, and are to be supplied under special guarantees as to quality. The price per ton is not disclosed, but is stated to be very low. Japan has also placed orders for lighter rails in France and Germany.

The National Physical Laboratory at Teddington has now added to its considerable equipment for the standardisation of electric lamps, and the investigation of characteristics of the sources of light, a complete photometer bench by Alexander Wright & Company, Limited, Westminster, the suppliers of the original equipment. Sheffield University and Huddersfield Technical College are being equipped with similar photometrical apparatus, and the Woolwich Polytechnic is installing a complete equipment for testing the calorific value of gas.

The directors of Harland & Wolff, Limited, state that the shipbuilding output of the company from its shipyards and engine works at Belfast, Glasgow and Greenock during the past five years to December 31, 1925 (exclusive of the output from the yards of associated companies), has been as follow:—Gross tonnage: 1921, 69,753 (59,600 h.p.); 1922, 113,227 (66,200 h.p.); 1923, 102,006 (71,450 h.p.); 1924, 105,389 (88,400 h.p.); 1925, 113,300 (88,540 h.p.). One of the subsidiary companies, the London and Glasgow Engineering & Iron Shipbuilding Company, Limited, being no longer required as a separate organisation, has been wound up, and its property and assets now appear under the appropriate headings in place of the shares of that company, which previously appeared among the investments.

A record of the 150 years' trading of the well-known firm of Rd. Johnson, Clapham & Morris, Limited, is contained in the "Manchester City News Business Centenary Supplement." The activities of the firm began in 1773, when James Howard founded a pin manufactory, wirework and wire weaving business in Market Sted Lane (Market Street). In 1804 the business moved to the School Mills, which stood on the present Victoria Station approach, by the side of the Irk. A Mr. Russell was taken into partnership in 1813, owing to the extension of the business; and in 1817 John Johnson, a pin manufacturer, resident in Picaddilly, joined the firm. Next year James Howard left, and his place was taken by Mr. Sharrocks. The business moved to Hyde's Cross in 1819, by which time it was the property of Johnson & Sharrocks (late Howard & Russell). The next move was to 22, Hanging Ditch, and then to Dale Street. Here, in 1830, the firm became Richard Johnson and Brother, and so continued till 1861, when Richard Johnson took into partnership two of his staff—Mr. Clapham and Mr. Morris. By this time the merchant business had been removed to Lever Street, and the wire works to Mill Street, Ancoats, necessitated by the revolutionary developments in the trade, and due to new inventions in manufacture. New works were built in Moston in 1900, and the Mill Street premises were used for storage. A large colonial trade necessitated the opening of branches in Australia and New Zealand, and the expanding home trade brought into being branches in London, Liverpool, Middlesbrough, Glasgow, and, most recently, Birmingham. The Mill Street warehouses proved too small, and a move was made to Trafford Park, where the firm has recently constructed the finest building of its kind in existence, planned only after a thorough inspection of all the latest American establishments. It is interesting to note that one-third of the ordinary shares of the company were, on incorporation in 1891, allotted to employees on special terms, and are still held by employees.

Obituary.

Mr. Francis Hird, who has died at the age of 59, was managing director of Siemens Bros. & Company, Limited, Siemens & English Electric Lamp Company, Limited, and Caxton Electric Developments, Limited, and a director of Siemens & General Electric Railway Signal Company, Limited, Elliott Bros. (London), Limited, the Enfield Cable Works, Limited, St. Helens Cable & Rubber Company, Limited, and the Fixed Price Light Company, Limited. In 1889 Mr. Hird joined the staff of Siemens Bros. & Company, Limited, and after a few years became chief dynamo designer to that company. In due course, after having gained some commercial experience, he became head of the electric light and power department of Siemens Bros. In connection with the various activities in electrical development proceeding at that time, it may be mentioned that Mr. Hird took a considerable personal share in the design and construction of the original equipment of the Waterloo and City Railway. For some time he was works manager of Siemens Bros. Dynamo Works, Limited, at Stafford, subsequently returning to Siemens Bros. & Company, Limited, in order to take charge of their apparatus department and to develop their light current work generally. In this connection he inaugurated their telephone department, and thus enabled Siemens Bros. & Company to be among the first to introduce practical automatic telephone exchanges in this country. Mr. Hird was appointed general manager of Siemens Bros. & Company, Limited, in 1922, and managing director in April, 1925.

Contracts Open.

Bristol, April 12.—(†8) Iron castings; (9) wrought-iron and steel; (17) black bolts and nuts; (†18) iron piping; (†31) lead; (†33) gun-metal castings, for Port of Bristol Authority, from May 1 to October 31. 1926. Mr. T. A. Peace, engineer, Avonmouth Dock

Johannesburg, April 10.—Five miles of 4/0 (0.4-in. diameter) round section cadmium copper trolley wire, for the Municipal Council of Johannesburg. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Reference No. A.X. 2959.).

London, S.E., April 13 to 26.—(1) best Yorkshire iron bars; (2) galvanised mild steel sheets for carriage panels; (3) metallic fittings for railway carriages; (4) galvanised iron wire; (5) brass angles, channels and strips; and (6) steel bridgework, for the Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. Tenders due on April 13 for Nos. 1 and 2, April 20 for Nos. 3, 4 and 5, and on April 26 for No. 6.

Manchester, April 13. — Supply and delivery of copper, silicum and cadmium bronze trolley wire, for the Tramways Committee. Mr. H. Mattinson, general manager and chief engineer, Corporation Tramways, 55, Piccadilly, Manchester.

Melrose, April 13.—Providing and laying about two miles of 6-in. diameter water pipes, for the Town Council. Messrs. Carfrae & Morrison, 1, Erskine Place, Edinburgh. (Fee, £1 returnable.)

Sofia, Bulgaria, April 15.—15,389 tons of materials for permanent-way (rails, fishplates, iron sleepers, etc.), for the Bulgarian State Railways. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Reference No. A.X. 2971.)

London, S.W.1, April 16.—(1) Locomotive boilers, (2) wheels and axles for carriages and wagons, (3) parts for constructing saloons and wagons, for the Bombay, Baroda and Central India Railway Company. The Offices, The White Mansion, 91, Petty France, S.W.1. (Fee, 20s. each for (1) and (2), and 10s. each for (3), non-returnable.)

Santiago, Chile, July 1-August 20.—The Chilean State Railways require the following goods:—(33) Spare parts for locomotives, carriages, and wagons; (36) signals, telegraphs, telephones, etc.; (37) electrical materials for sub-stations, aerial lines, and lighting (1st Zone). The Departmnet of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Wills.

Coward, J., a director of the North Lonsdale Iron & Steel Company, Limited.	£33,658
Berridge, O., of Hinckley, Leics., engineer, etc., managing director of Parsons, Sherwin & Company, Limited	£8,327
Hayward, J. B., of Wolverhampton, managing director of William Hayward & Sons, Limited, fence and gate manufacturers	£12,184
Robinson, Samuel, of Widnes, for many years a director of Widnes Foundry Company	£8,270

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These qualities are solidly built into all Sterling Boxes. There are twenty different standard styles of Sterling Boxes. Each style has been minutely studied in every detail and has been designed to fulfil a specific foundry service with final economy.

As it is never too soon to introduce an economy write to us to-day and ask our representative to call upon you and discuss the Sterling Box from the point of view of *your* Foundry.

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SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

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IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—With business practically suspended over the early part of the week, there is little fresh to chronicle in regard to the Cleveland iron trade, both home and export demand remaining quiet, while prices at the moment are nominally without change. The outlook meantime is regarded with some anxiety, awaiting more definite information on the issue of the coal negotiations, which at present appear to be only in the initial stage. Meanwhile there is a manifest reluctance on the part of consumers to cover more than immediate needs, and business is restricted accordingly. Makers still adhere to the prices which have been current for several weeks past, No. 1 being 73s., No. 3 G.M.B. 70s. 6d., No. 4 foundry 69s. 6d., and No. 4 forge 68s. 6d. per ton. Home quotations are 6d. per ton less.

The hematite position continues distinctly easier. Orders are now clearing off, and producers are keen to book further business. Home demand is quiet, and there is very little Continental inquiry at the moment. An outside figure for East Coast mixed numbers is now 76s. 6d. per ton, with No. 1 quality 77s. per ton. On the North-West Coast prices are adversely affected by the depression in trade, Bessemer mixed numbers being quoted at £4 5s. to £4 7s. 6d. per ton delivered at Glasgow, £4 8s. to £4 10s. per ton delivered at Sheffield, and £4 11s. 6d. to £4 13s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—Makers of foundry pig in this locality are still fairly well occupied on orders in hand, but they are not booking much new business at the moment, although there is a feeling that a spurt will take place shortly. Prices quoted in this centre are very firm, and there is little evidence of weakening. Derbyshire No. 3 pig-iron, delivered in Manchester or equal distance, is still being offered at 75s. to 76s. per ton, with Lincolnshire and Staffordshire makes at about 76s., while Scotch iron is quoted at 94s.

THE MIDLANDS.—In South Staffordshire and adjacent markets, demand for foundry iron continues moderate in volume, with values firmly held for most of the leading brands, the ruling quotations being as follow:—Derbyshire No. 3 foundry, 66s. 6d. to 67s. 6d.; Staffordshire No. 3 foundry, 66s. 6d. to 67s. 6d.; Northants. No. 3 foundry, 62s. 6d. to 63s. 6d.

SCOTLAND.—So far there are no signs of an early recovery in the demand for Scottish foundry pig, with business remaining in a very depressed state. There has been no change, however, in prices, No. 3 quality being quoted at 76s. 6d. at the furnace.

Finished Iron.

Midland manufacturers of this class of material report no improvement in the demand for bars, and there is still a great deal of competition for the limited orders for crown iron that are available. The lowest quotation is £11, and the average price would be between this and £11 5s., delivered to warehouse locally. Little support is being given to the makers of nut and bolt and fencing iron. For this class of iron there is not even a very big demand from Belgium at the moment, although the latter mills take the bulk of the available business purely on account of price. They are quoting £6 10s. to £6 12s. 6d., delivered works this area, whilst the lowest local price for bolt iron is £10 5s. It is impossible, therefore, for the Staffordshire mills to get but a small proportion of the business. Marked bars are unchanged at £14, f.o.t. makers' works, but orders are very slow in coming through.

Scrap.

Business in the various markets for scrap metal continues exceptionally quiet, and in Scotland there is still only a poor demand for heavy machinery cast iron, but merchants are still quoting 73s. 6d. to 75s. per ton, with little business doing. Ordinary heavy cast-iron scrap in pieces not exceeding 1 cwt. is about 5s. per ton less, and for steel works cast iron the price is still around 67s. 6d. per ton. Old cast-iron railway chairs remain unchanged at 73s. 6d. to 74s. 6d. per ton, and for light cast-iron scrap and firebars 61s. to 62s. per ton. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—The tendency of standard copper values of late has been largely influenced by the sharp slump in the American share markets, while consumptive demand for the metal, both at home and abroad, has been much below the average anticipated. Within the last few months the German purchases from America direct have remained abnormally restricted, although conditions in the German industry are said to be improving a little. France, on the other hand, has been at the head of the list in the takings from America during the last few months, and her consumption is comparatively good. Current quotations:—*Cash*: Wednesday, £57 7s. 6d.; Thursday, £57 17s. 6d.; Tuesday, £57 17s. 6d.; Wednesday, £57 10s.

Three Months: Wednesday, £58 7s. 6d.; Thursday, £58 15s.; Tuesday, £58 15s.; Wednesday, £58 7s. 6d.

Tin.—Due to the belated arrival of a cargo of tin in New York at the month's end, the reduction in the visible supplies of the metal at the end of March was not so great as anticipated. Nevertheless, at 13,397 tons stocks show a fall of 1,704 tons, which is considerable in view of the low level they had already reached. Though the statistical position is still somewhat uncertain, the market rallied at last week's close, and an advance was recorded, both for prompt and forward deliveries. Current quotations:—*Cash*: Wednesday, £284 10s.; Thursday, £287 15s.; Tuesday, £286 15s.; Wednesday, £285.

Three Months: Wednesday, £276 10s.; Thursday, £279 15s.; Tuesday, £277 15s.; Wednesday, £274 15s.

Spelter.—In regard to the position of this section R. Wolff & Company write:—The zinc market has come under the influence of the general depression which seems latterly to have overtaken the metal situation. Demand on the part of the consumers has, if anything, slightly improved, and rather more favourable reports are received regarding the situation in Germany, where some improvement in industrial conditions is anticipated, and in consequence of which there has been on the whole less pressure to sell, with indication of a slightly better demand. Current quotations:—*Ordinary*: Wednesday, £33 5s.; Thursday, £33 11s. 3d.; Tuesday, £33 10s.; Wednesday, £33 5s.

Lead.—In the market for soft foreign pig, consumers on the whole have bought fairly freely, but the water supply at Broken Hill having been fully restored, the market has eased again. Yet stability should be fairly well assured at the current level, due to decreased arrivals. Current quotations:—*Soft foreign (prompt)*: Wednesday, £30 5s.; Thursday, £30 10s.; Tuesday, £30 2s. 6d.; Wednesday, £29 16s. 3d.

THE QUESTION of foreign competition, particularly in the importation of second-hand tools, came under consideration at the annual meeting of the Machine Tool Trades' Association, held in London on March 24, when it was announced that the Association's exhibition for 1928 would be held at Olympia for a fortnight commencing on September 5. Mr. Butterworth said that manufacturers had got over the disadvantage of the heavy surplus left over from the war, which had been absorbed, but now second-hand machine tools were being imported from America, and he thought more prohibitive steps should be taken. The secretary, dealing with a suggestion that the matter might come under the Safeguarding of Industries Act, pointed out that Part II of the Act under which it might have come lapsed in August, 1924, and it was now necessary to apply to the Board of Trade, who could appoint a Committee of Inquiry which might recommend duties, and these could only be imposed by special Act of Parliament. The chairman said there would be the further difficulty of reconditioned machine tools, and he was not very hopeful that anything could be done.

DEATH OF MR. J. E. GIBSON.—We regret to announce that Mr. John E. Gibson, secretary of the Falkirk Section of the Institute of British Foundrymen, died on Saturday, April 3, of typhoid fever. The deceased gentleman has held the position of secretary of the Falkirk Section for about two years. He was the elder son of Mr. William J. Gibson, architect, Armont, Falkirk, at which residence he died at the age of 25 years. Mr. Gibson was an engineer, and worked for some time with R. & A. Main, Limited, Gothic Iron Works, Falkirk, and latterly with Walker, Hunter & Company, Limited, Port Downie Iron Works, Falkirk. He was a nephew of the late Mr. Hunter of that firm, and was regarded as a young man of very considerable promise in the foundry trade. The Institute was represented at the funeral by Mr. J. M. Primrose.

Telegrams: "THROWER, GLASGOW." Telephone: 5909 CENTRAL.

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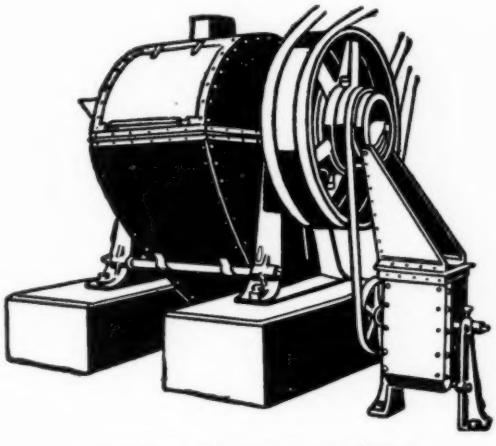
Head Office: 60, St. ENOCH SQUARE, GLASGOW.



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BRASS RECOVERY MACHINES

are the last word in the Treatment of Brass Foundry

ASHES AND SKIMMINGS.

If you don't want to lose what your Competitor is saving, you must write to us about it now.

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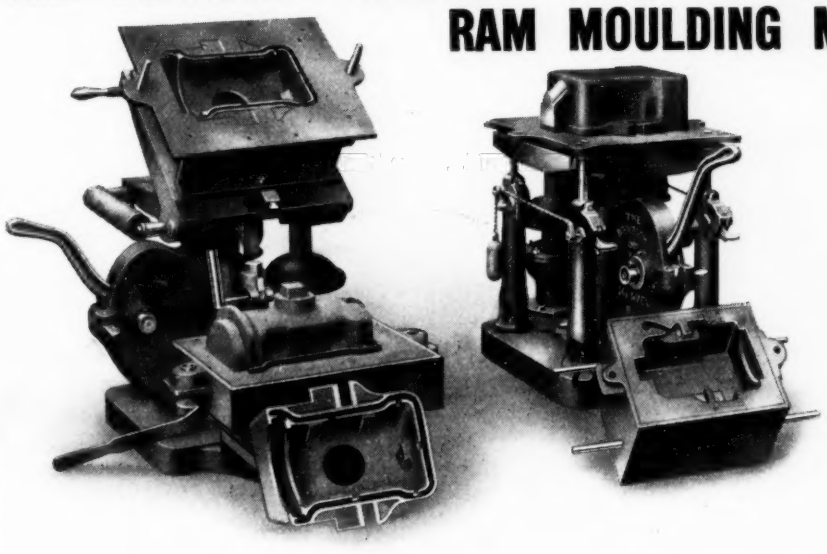
THE DENBIGH "MARVEL" PATENT HAND JOLT RAM MOULDING MACHINE



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NO POWER but ALL advantages POWER gives.

We can now supply the WHOLE equipment for making 12 ton AXLE BOXES to Drawing 1031 (latest) THE RAILWAY BUFFER BLOCK and BRAKE BLOCKS. These are always wanted and in LARGE quantities. WHY DON'T YOU QUOTE?

SEE US for your patterns (Iron) all passed to R.C.H. Gauges.
WE see to this. Write us or phone.

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Phone: 86. **TIPTON.** *'Grams: "Denbigh."*

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	57	10	0
Three months ..	58	7	6
Electrolytic	64	15	0
Tough	60	10	0
Best selected ..	61	5	0
Sheets	90	0	0
India	74	0	0
Wire bars	65	5	0
Do. April	65	0	0
Do. May	65	0	0
Ingot bars	65	0	0
H.C. wire rods ..	69	10	0
Off. av. cash, Mar..	58	13	3 1/8
Do., 3 mths. Mar.	59	12	5 3/8
Do., Sttlmnt, Mar.	58	13	0 1/16
Do., Electro, Mar.	65	13	7 3/4
Do., B.S., Mar ..	62	10	3 1/2
Aver. spot price copper, Mar. ..	58	13	0 1/2
Do., wire bars, Mar.	65	17	4 1/4
Solid drawn tubes			13d.
Brazed tubes ..			13d.
Wire			10d.

BRASS.

Solid drawn tubes ..	12d.
Brazed tubes	13½d.
Rods, drawn	10¾d.
Rods, extd. or rlld. ..	7½d.
Sheets to 10 w.g ..	10½d.
Wire	9¼d.
Rolled metal	9½d.
Yellow metal rods ..	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets ..	8½d.

TIN.

Standard cash ..	285	0	0
Three months ..	274	15	0
English	283	5	0
Bars	287	5	0
Straits	289	5	0
Australian	287	7	6
Eastern	280	15	0
Banca	287	0	0
Off.aver. cash, Mar.	292	8	6 9/16
Do., 3 mths., Mar.	283	12	11 15/16
Do., Sttlmt. Mar.	292	8	5 15/16
Aver. spot., Mar.	292	8	6½

SPELTER.

Ordinary	33	5	0
Remelted	33	10	0
Hard	27	10	0
Electro 99.9 ..	38	0	0
English	34	2	6
India	30	0	0
Zinc dust	42	0	0
Zinc ashes	14	10	0
Off. aver., Mar. ..	34	3	4 10/16
Aver., spot, Mar.	34	1	9½

LEAD.

Soft foreign ppt.	29	16	3
English	31	5	0
Off. average, Mar.	31	15	5 5/16
Average spot, Mar.	31	12	6

ZINC SHEETS, &c.

Zinc sheets, English	41	0	0
Do. V.M. ex whf.	39	10	0
Rods	44	0	0
Boiler plates ..	39	10	0
Battery plates ..	39	0	0

ANTIMONY.

Special brands, Eng.	89	10	0
Chinese	80	0	0
Crude	54	0	0

QUICKSILVER.

Quicksilver ..	14	2	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon	
25%	9 10 0
45/50%	11 14 0
75%	20 12 6
Ferro-vanadium—	
35/40%	14/5 lb. va.
Ferro-molybdenum—	
70/75% c. free	6/- lb.
Ferro-titanium—	
23/25% carbonless	11½d. lb.
Ferro-phosphorus, 20/25%,	£17 0 0
Ferro-tungsten—	
80/85%, c.fr. ..	1/9½ lb.
Tungsten metal powder—	
98/99%	2/1 lb.
Ferro-chrome—	
2/4% car. ..	£35 0 0
4/6% car. ..	£22 7 6
6/8% car. ..	£21 15 0
8/10% car. ..	£20 17 6
Ferro-chrome—	
Max. 2% car.	£38 10 0
Max. 1% car.	£44 10 0
Max.0.70%car.	£54 10 0
70%, carbonless	1/5½ lb.
Nickel—99%, cubes or pellets ..	£170
Cobalt metal—98/99%	10/- lb.
Aluminium 98/99%	£112
Metallic Chromium—	
96/98% ..	3/3 lb.
Ferro-manganese (net)—	
76/80%, loose	£15 0 0
76/80%, packed	£16 0 0
76/80%, export	£15 0 0
Metallic manganese—	
94/96%, carbonless	2/- lb.
Per ton unless otherwise stated.	

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten ..	s. d. 2 6
Finished bars, 18% tungsten ..	3 0
Per lb. net, d/d buyers' works.	
Extras—	
Rounds and squares 3 in. and over ..	4d.lb.
Rounds and squares under ½ in. to ¼ in.	3d. lb.
Do. under ¼in. to 1/8 in.	1/- lb.
Flats, ½in. × ¼in. to under 1 in. × ⅜ in.	3d. lb.
Do. under ½in. × ¼in.	1/- lb
Bevels of approved sizes and sections	6d. lb.
Bars cut to length	10% extra
Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.
Per lb. net, d/s steel makers' work	

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Hvy. steel	3 8 6 to	3 12 6
Bundled steel & shrngs.	3 3 6 to	3 7 6
Mixed iron & steel	3 2 6 to	3 5 0
Heavy cast iron	3 2 6 to	3 6 0
Good machinery for foundries	3 7 6 to	3 10 0
Cleveland—		
Heavy steel ..	3 4 6	
Steel turnings ..	2 7 6	
Cast iron borings	2 5 0	
Heavy forge ..	4 5 0	
Bushelled scrap	3 10 0	
Cast-iron scrap	3 7 6	
Lancashire—		
Cast-iron scrap	3 10 to	3 15 0
Hvy. wrought ..	3 5 0	
Steel turnings ..	2 2 0	
London — Merchants' buying prices delivered yard.		
Copper (clean)..	48 0 0	
Brass (clean) ..	38 0 0	
Lead (less usual draft)	26 10 0	
Tea lead ..	22 10 0	
Zinc	23 0 0	
New aluminium cuttings ..	80 0 0	
Braziery copper	43 0 0	
Gunmetal ..	45 0 0	
Hollow pewter	185 0 0	
Shaped black pewter ..	136 0 0	

PIG-IRON.

(f.o.t. unless otherwise stated).

N.E. Coast—	
Foundry No. 1 ..	72/6
Foundry No. 3 ..	70/-
Foundry No. 4 ..	69/-
Forge No. 4	68/-
Hematite No. 1 ..	77/6
Hematite M/Nos. ..	77/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/3
,, d/d Birm.	92/9
Midlands—	
Staffs common* ..	—
,, No. 4 forge ..	62/6
,, No. 3 foundry	67/-
Shrops. basic	70/-
,, Cold blast, ord.*	185/-
,, ,, roll iron* ..	190/-
* d/d Birmingham.	
Northants forge	56/6
,, fdry No. 3 ..	63/-
Derbyshire forge ..	60/6
,, fdry. No. 3 ..	67/-
,, basic	65/-
Scotland—	
Foundry No. 1 ..	81/6
,, No. 3 ..	76/6
Hem. M/Nos.	76/6
Sheffield (d/d district)—	
Derby forge	66/-
,, fdry. No. 3 ..	71/-
Lincs. forge	67/6
,, fdry. No. 3 ..	70/-
E.C. hematite	87/6
W.C. hematite ..	89/-
Lincs. (at furnaces)—	
Forge No. 4	61/6
Foundry No. 3.. ..	64/-
Basic	64/-
Lancashire (d/d eq. Man.)—	
Derby forge	68/-
,, fdry. No. 3 ..	75/6
Northants foundry No. 3	75/9
Dalzell, No. 3	110/-
Summerlee, No. 3 ..	94/-
Glengarnock, No. 3 ..	94/-
Gartsherrie, No. 3 ..	94/-
Monkland No. 3	94/-
Coltness, No. 3	94/-
Shotts, No. 3	94/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars(cr.)	11 0 0 to	12 0 0
Angles	11 10 0	
Tees to 3 united ins.	12 0 0	
Nut and bolt	10 5 0 to	10 7 6
Hoops	14 0 0 to	15 0 0
Marked bars (Staffs.) f.o.t. ..	14 0 0	
Gas strip	12 10 0	
Bolts and nuts .. ¾ in. × 4 in. ..	15 5 0	
Steel—		
Ship plates	7 10 0 to	7 15 0
Boiler plts. ..	11 10 0	
Chequer plts. ..	9 15 0	
Angles	£7 0 0 to	7 5 0
Tees	£8 0 0 to	8 5 0
Joists	£7 0 0 to	7 5 0
Rounds and Squares 3 in. to 5½ ins. ..	8 0 0	
Rounds under 3 in. to ¾ in.	7 15 0	
Flats, over 5 in. wide and up ..	8 10 0	
Flats, 5in. to 1½in.	7 10 0	
Rails, heavy ..	8 0 0	
Fishplates	12 0 0	
Hoops (Staffs.) ..	10 10 0	
Black sheets, 24g.	11 5 0	
Galv. cor. sheets, 24g.	16 0 0	
Galv. fencing wire 8g. plain	14 0 0	
Billets,soft	£6 2 6 to	6 5 0
Billets, hard ..	8 2 6	
Sheet bars	6 0 0 to	6 2 6
Tin bars d/d	6 2 6 to	6 5 0

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to w.g.	1	3½
Wire	1	3½
Rods	1	3
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks ..	9d. to 1/5½
Ingots rolled to spoon size ..	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	23.26
No. 2 foundry, Valley	22.26
No. 2 foundry, Birm.	22.00
Basic	21.76
Bessemer	22.76
Malleable	22.26
Grey forge	21.76
Ferro-mang. 80% d/d	90.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars ..	36.00
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.22
Steel bars	2.00
Tank plates	1.85
Beams, etc.	1.90
Skelp, grooved steel ..	1.90
Skelp, sheared steel ..	1.90
Steel hoops	2.50
Sheets, black, No. 28..	3.25
Sheets, galv., No. 28 ..	4.50
Sheets, blue an'l'd, 9 & 10	2.50
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv. ..	3.35
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry ..	32/6 to 37/6
,, furnace ..	20/- to 25/-
Durham & North.	
,, foundry	30/- to 33/-
,, furnace	15/- to 15/6
Other Districts, foundry	30/- to 33/-
,, ,, furnace (basis)	11/9

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	19/4½
,,	28×20, ,,	38/9
,,	20×10, ,,	29/1½
,,	18¾×14, ,,	20/4½
C.W.	20×14, ,,	17/7½
,,	28×20, ,,	35/3
,,	20×10, ,,	24/1½
,,	18¾×14, ,,	18/4½

Terneplates 28×20, 35/9 per box basis f.o.b.

SWEDISH IRON.

Bars,hammered	£18/10 to £19/0
Rolled Ord.	£15/15/0 to £16/5/0
Nail rods	£16 5 0 to £16 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£9 to £12
Pig-iron	£6 10 0 to £7 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes	*Fittings*
Gas	60%	50%
Water	55%	45%
Steam	50%	40%

W.I. 10% extra.

Electrolytic Copper.

	£	s.	d.		
Mar. 31	64	5	0	dec.	10/-
Apr. 1	64	15	0	inc.	10/-
,, 6	64	15	0	No change	
,, 7	64	15	0	,,	,,

Tin (English ingots).

	£	s.	d.		
Mar. 31	283	0	0	dec.	70/-
Apr. 1	286	5	0	inc	65/-
,, 6	285	5	0	dec.	20/-
,, 7	283	5	0	,,	40/-

Spelter (ordinary).

	£	s.	d.		
Mar. 31	33	5	0	No change	
Apr. 1	33	11	3	inc.	6/3
,, 6	33	10	0	dec.	1/3
,, 7	33	5	0	,,	5/-

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.		
Mar. 31	57	7	6	dec.	7/6
Apr. 1	57	17	6	inc.	10/-
,, 6	57	17	6	No change	
,, 7	57	10	0	dec.	7/6

Standard Tin (Cash).

	£	s.	d.		
Mar. 31	284	10	0	dec.	65/-
Apr. 1	287	15	0	inc.	65/-
,, 6	286	15	0	dec.	20/-
,, 7	285	0	0	,,	35/-

Zinc Sheets (English).

	£	s.	d.		
Mar. 31	41	0	0	dec.	20/-
Apr. 1	41	0	0	No change	
,, 6	41	0	0	,,	,,
,, 7	41	0	0	,,	,,

Lead (English).

	£	s.	d.		
Mar. 31	31	15	0	No change	
Apr. 1	32	0	0	inc.	5/-
,, 6	31	15	0	dec.	5/-
,, 7	31	5	0	,,	10/-

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
1895	£ s. d. 2 3 0	£ s. d. 2 3 0	£ s. d. 2 2 6	£ s. d. 2 2 6	£ s. d. 2 2 6	£ s. d. 2 4 0	£ s. d. 2 3 6	£ s. d. 2 4 0	£ s. d. 2 5 0	£ s. d. 2 5 6	£ s. d. 2 6 6	£ s. d. 2 5 6	£ s. d. 2 3 11½
1896	2 5 6	2 6 0	2 6 0	2 6 0	2 6 0	2 5 6	2 5 0	2 5 0	2 5 0	2 6 0	2 7 0	2 8 6	2 5 11½
1897	2 10 0	2 11 0	2 9 0	2 8 6	2 8 0	2 7 0	2 7 0	2 6 0	2 6 0	2 6 0	2 6 6	2 7 6	2 7 9½
1898	2 7 6	2 8 0	2 8 0	2 8 0	2 8 6	2 10 0	2 10 0	2 10 0	2 10 0	2 11 0	2 14 0	2 14 0	2 9 11
1899	2 13 0	2 14 0	2 14 0	2 14 0	3 0 0	3 2 0	3 13 0	3 16 6	3 15 0	3 16 6	3 16 6	4 0 0	3 6 2½
1900	4 0 0	4 0 0	4 0 0	4 1 6	4 1 0	3 18 0	3 13 6	3 12 6	3 11 0	3 11 0	3 9 6	3 8 0	3 15 5
1901	2 13 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 3¾
1902	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1¼
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12 6	2 12 6	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2½
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 16 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926	3 14 9	3 15 3	3 15 6	—	—	—	—	—	—	—	—	—	3 15 2

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
ANGAPPA NAICK STREET, MADRAS.

REGISTERED TRADE MARK

1, HONG KONG ROAD, SHANGHAI.
OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR
5, SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.
P.O. BOX 1580, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE

WILLIAM JACKS & COMPANY,

93, HOPE STREET, GLASGOW.

ROYAL EXCHANGE, MIDDLESBROUGH.

XUM

SITUATIONS VACANT AND WANTED.

FOREMAN MOULDER, 40 years of age, desires position; experience Marine, Hydraulic, General, Elect., Railroad, Brass or Iron.—Box 686, Offices of The Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WORKING FOUNDRY FOREMAN required, with good practical experience of Stump and Machine Moulding, small Castings, Cupola work, Annealing by Dowson & Mason Gas Oven; single man preferred; must be good organiser; London district.—Full particulars, Box 678, Offices of The Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

REQUIRED, Representatives for Company manufacturing Foundry Requisites (Core Binder, Core Oils, Fluxes, etc.); state in reply full particulars of experience and ground covered; splendid opportunity to Salesman having already a good connection with Foundries.—Box 692, Offices of The Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

EX-OFFICERS AND OTHER RANKS.

The Proprietors of the Foundry Trade Journal have placed this space at the disposal of the British Legion, Officers' Association, Employment Bureau, 3-4, Clement's Inn, Strand, London, W.C.2. (telephone: Holborn 5769), to whom all replies should be addressed, quoting number of advertisement, date on which it appeared, and the name of this paper.

EX-OFFICER, with general commercial and engineering training, desires Secretarial work; book-keeping and staff control; energetic; thoroughly trustworthy and reliable; open to accept any position at a moderate salary at home or abroad. (Dis. 48)

ELECTRICAL AND MECHANICAL ENGINEER, M.I.E.E., late Major, Royal Engineers; all-round experience, executive and practical, A.C. and D.C., steam and internal-combustion engines, turbines, boilers, wiring, overhead and underground distribution, reports, estimating, handling of men, typing, shorthand, accounts. (614)

QUALIFIED ENGINEER AND NAVAL ARCHITECT, A.M.I.N.A., A.M.I.M.E., age 41, expert design and construction light-draft vessels for export in section and pieces, all classes of small craft for all purposes, mineral dredges and structural steelwork, etc., first-class draughtsman and good estimator, requires position; used to taking charge and full responsibility; 25 years' experience. (5526)

MECHANICAL ENGINEER, 48, married, Public School, regular apprentice marine engineering, four years' draughtsman general engineers, 10 years' superintending engineer, rubber companies' experience, designing and erecting factories, etc., office work, special knowledge vacuum drying plant, rubber and vegetable products, requires post, Factory Engineer or Adviser and Consultant *re* machinery, etc., required for East. (1333)

BUSINESS FOR SALE.

Re HENRY MOSELEY & SONS, LIMITED, Bath Street Works, Walsall, Buckle and Harness Fittings Manufacturers and General Founders in Malleable and Cast-iron and Brass.

OFFERS ARE INVITED for the above well-known old-established BUSINESS AS A GOING CONCERN. The assets consist of: Engineering and Foundry Plant and Machinery, Going Gear, Loose Tools, Finished and Unfinished Stock and Materials, valuable Patterns, Office Furniture, and Goodwill, with the benefit of orders in hand; book debts optional.

The FREEHOLD PREMISES, which are held on a lease with approximately 18½ years unexpired, at a rental of £450 per annum, may be purchased separately if required.

For further particulars, apply to—
The Receiver for Debenture Holders,
MR. R. W. RUTLEDGE,
Chartered Accountant,
131, Edmund Street, Birmingham.

PATENTS.

SAND CUTTING AND PILING MACHINES.

THE OWNERS of British Patent No. 198165 desire to dispose of the same, or would grant a licence to work the invention on royalty terms.—Particulars may be obtained from Technical Records, Limited, of 59-60, Lincoln's Inn Fields, London, W.C.2.

THE Proprietor of British Patent No. 147,931, dated April 8, 1916, relating to "Improvements in Sheet and Tin Mill Furnace," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to Mr. B. Singer, Woolworth Building, New York City, U.S.A.

PATENTS.—*Continued.*

THE Proprietor of British Patent No. 159,428, dated April 9, 1920, relating to Device for Removing Surface Defects from Steel Billets "while hot," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. Singer, Steger Building, Chicago, Illinois.

AUCTION SALE.

By Order of the Liquidator, F. Holt, Esq., A.C.A.

GLOBE FOUNDRY, STRATFORD, LD.,
43, CHATSWORTH ROAD, STRATFORD, E.
FREEHOLD AND LEASEHOLD IRON FOUNDRY,
TOGETHER WITH
FOUNDRY AND ENGINEERING PLANT AND MACHINERY.

The premises comprise several buildings of one storey, with Foundry, covering a site area of half an acre. The property has three entrances. A small portion of the premises is held on lease.

The Foundry has an output capacity of approx. 30 tons per week.

LEOPOLD FARMER & SONS will offer the above to Auction, in ONE or MORE LOTS, on the Premises on TUESDAY, 20th APRIL (unless previously disposed of).

Particulars and Catalogues of F. Holt, Esq., A.C.A., of Messrs. Arthur Goddard & Co., Chartered Accountants, 46, London Wall, E.C.2; Messrs. Helliwell, Harby & Evershed, Solicitors, 231, Strand, W.C.2; and the Auctioneers.

MACHINERY

SAND MIXERS.—New and second-hand. Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

PATTERNMAKER'S Wood Planing and Thicknessing Machine, 20 in., by Sagar; not done six months' work; very cheap.—Box 684, Offices of The Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

10-TON DENISON CRANE HOOK, suspension type, Weighing Machine.—Fyfe, Wilson & Co., Ltd., 31, Budge Row, E.C.4.

MACHINERY, PLANT, &c.

HYDRAULIC ACCUMULATOR, 13-in. ram, 16 ft. stroke, M.S. casing, 9 ft. diam., 20 ft. high, 1,500 lbs. pressure.

Nearly New HYDRAULIC INTENSIFIER, rams 17 in. x 9½ in. diam., 5-ft. stroke, hydraulic pressure 1,500 lbs.

250-tons POWERFUL HYDRAULIC PRESS, 22-in. ram, 1,500 lbs. working pressure; by Hy. Berry & Co.

SET OF THREE HYDRAULIC PUMPS, 4½-in. rams, 15-in. stroke; by Hathorn Davey & Co.; driven by 250 h.p. A.C. Motor.

LANCASHIRE BOILER, 30 ft. x 8 ft.; reinsure 110 lbs. per sq. inch working pressure.

Two High-class Nearly New SCOTCH MARINE BOILERS, about 11 ft. 6 in. long x 16 ft. diam., for 180 lbs. working pressure.

CATALOGUE (10,000 LOTS) ON APPLICATION.

THOS W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

66" **CUPOLA**, by Thwaites, drop bottom, been little used; 10 tons per hour at BLACKBURN £150

ELECTRIC BLOWER by Keith-Blackman, 12" outlet, with 19 h.p. variable speed motor and starter for above cupola £50

48" **CUPOLA**, by Thwaites, as above, but no spark arrester at BLACKBURN £90

30" **CUPOLETTE**, by Constructional Co., with pipes and fan complete... ... ... £32

NEW LADLES—CHEAP.

12 Ton EVANS	£95
5 Ton McNEIL	£38
3 Ton THWAITES	£32
2½ Ton by GEORGE GREEN	£30
2 Ton THWAITES	£26

BUY FROM ME AND SAVE MONEY.

ALEX. HAMMOND, *FOUNDRY MACHINERY MERCHANT,*
14, AUSTRALIA ROAD, SLOUGH.